Leffel

SCOTCH MARINE BOILERS

and Steam Engines

BULLETIN NO. 216

3rd Edition

The James Leffel & Co.

Since 1862 Manufacturers of Boilers and Steam Engines

Springfield, Ohio, U.S.A.

Size 200 H. P. Leffel Scotch Marine Boiler

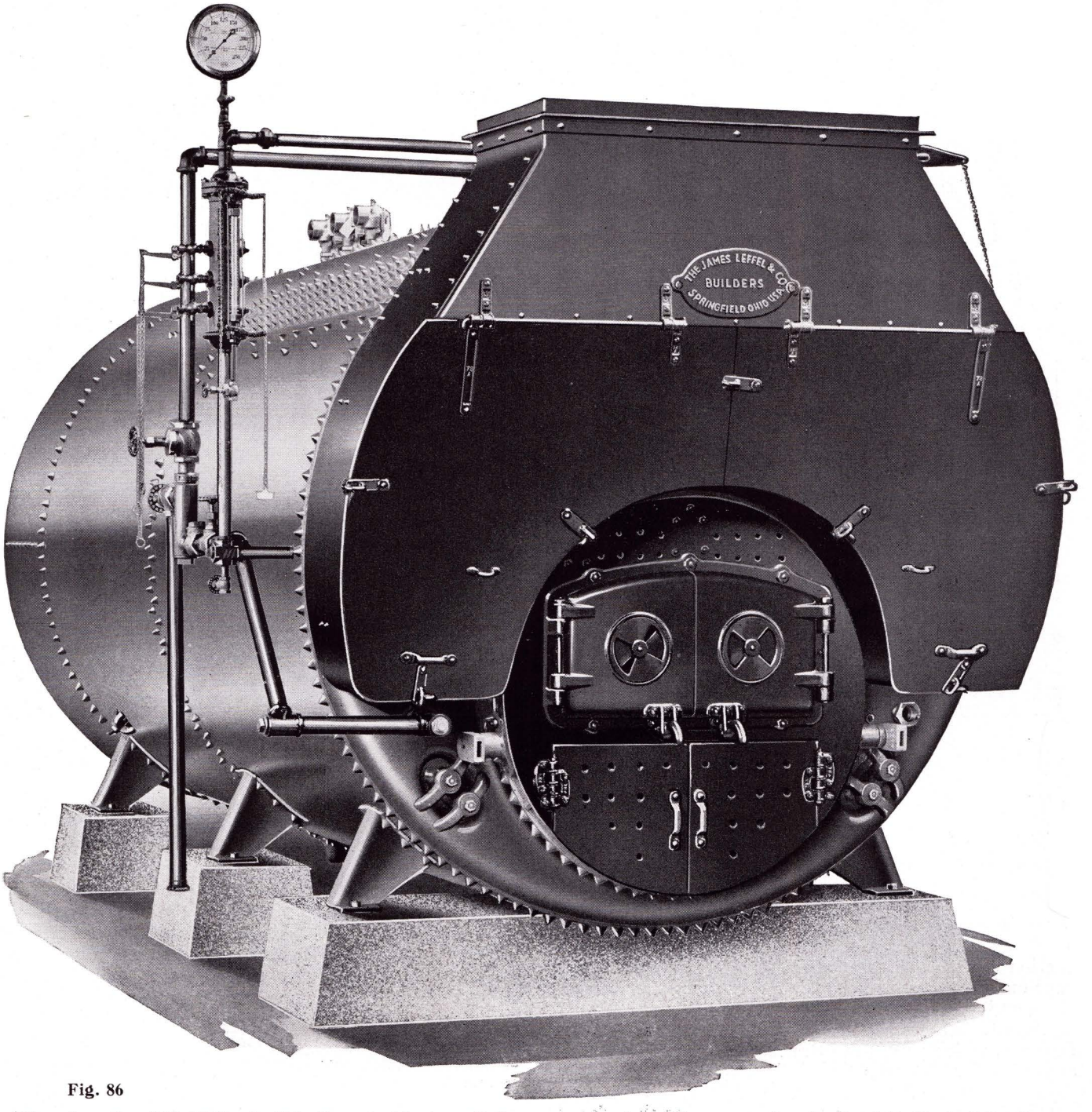


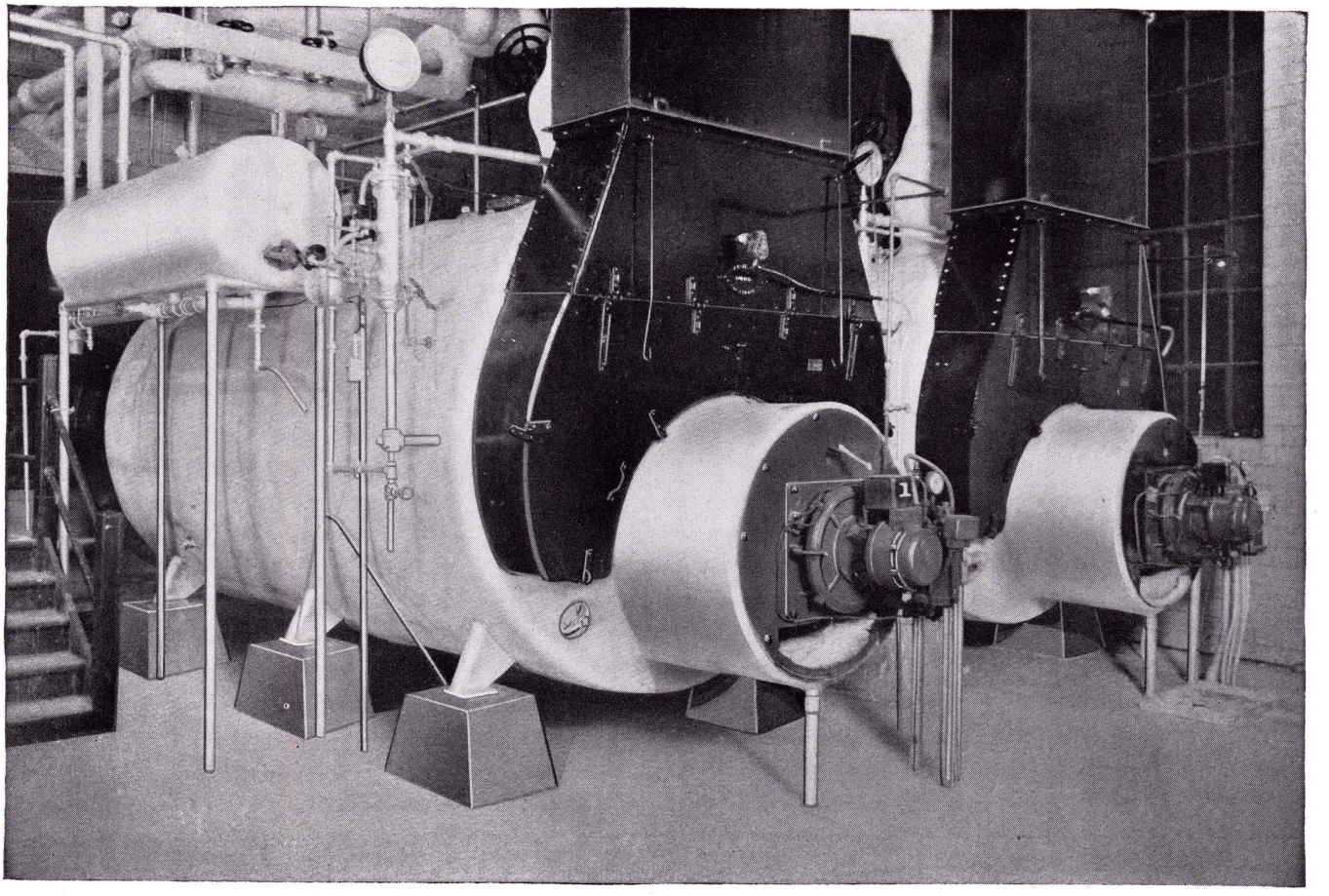
Fig. 86

Showing the 200 H.P., Leffel, Scotch Marine Boiler set on Concrete Piers and equipped with Safety Valves, Blow-Off Valve, Steam Gauge, High and Low Water Alarm Column and Injector, all fitted to Boiler. Notice the large, double Fire Doors, Ash Pit Doors and Smoke Box Doors, providing easy and complete access to the fire, ash pit and return tubes.

These Boilers are Scientifically designed and correctly proportioned throughout. They are carefully and ruggedly constructed from the most suitable materials. These Boilers will withstand hard service and heavy overloads. They may be fired with Coal, Oil, Gas or Wood. Coal may be fired by hand, Pulverizer or a Leffel Stoker.

These Boilers are easy to clean, inspect or repair. They have an exceptionally long life with a minimum amount of repairs. A stronger, safer, more dependable or more economical Boiler cannot be found. These Boilers will serve **you** best and produce your steam with less fuel than other types. Users report fuel savings ranging from **20** to **40** per cent over other types.

Showing an installation of (2) size 145 H. P. Leffel Scotch Marine Boilers. These Boilers are fired with oil as fuel.



When Leffel Boilers are installed, as illustrated in the above picture, your Boiler room becomes as attractive as any other part of your Plant. The manner in which these two Boilers are covered with Insulation insures against radiation loss of the heat stored in the water and steam inside of the Boilers. This heat is saved for use as dry steam when you want it.

Notice that the Boiler legs are set on concrete piers, thus affording a permanent setting, which also affords ample access to the hand holes and blow-off valve connection underneath the Boilers. This large, open clearance makes it easy to keep the Boiler room floor washed clean and attractive.

The Oil Burners are mounted on the special Ignition Furnace, which places the Burners where they are most accessible for any attention desired. These Burners are electric driven, but may be also of the steam or air type.

When the Burners are mounted similar to that shown above, they discharge a horizontal, circular flame, which exactly fits the large, cylindrical furnace in Leffel, Scotch Marine Boilers. These Furnaces are full size all the way through the Boiler, thus affording ample combustion space.

Inasmuch as water ***completely*** surrounds the ***steel*** furnaces in Leffel, Scotch Marine Boilers, the enormous amount of heat from the fire is immediately absorbed by the water for quickly generating steam, and, therefore, is not lost by entering brick work or the refractories necessary in other types of Boiler furnaces. These other brick or refractory lined furnaces are quickly destroyed by the extreme heat of complete combustion, whereas the water cooled, steel furnaces in Leffel, Scotch Marine Boilers use this same heat for making steam without injury to the furnace. By the time the fuel gases have reached the rear end of the Leffel Boiler, the combustion has been completed and the excessive heat has gone into the surrounding water to make steam; therefore, the temperature of the fuel gases has been lowered to where they do not injure the rear end construction, or the ends of the return tubes, as is done in Boilers ***not*** having sufficient, ***water cooled,*** gas travel before the gases enter the small tubes.

You will find that in these Leffel, Scotch Marine Boilers there is sufficient combustion space and heating surface for efficient steaming at fully double their rating, yet this combustion space and heating surface is not too great to keep these Boilers from operating efficiently on light loads or low ratings. Therefore, the Oil Burners may be adjusted to any rating desired and with a positive assurance that your steam is being generated at all times with the least possible amount of fuel.

See Page 15

Since 1862

In 1862, before the close of the Civil War, James Leffel, an inventor and engineering genius, founded The James Leffel & Co. at Springfield, Ohio.

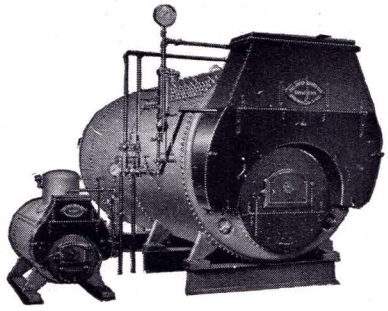
Here he began the manufacture of Turbines, Steam Engines, and Boilers, at once becoming a factor in the great reconstruction of the country. He recognized that industrial progress was dependent on the economical and efficient use of power, and so started the work that his associates and successors have carried on for the past 78 years.

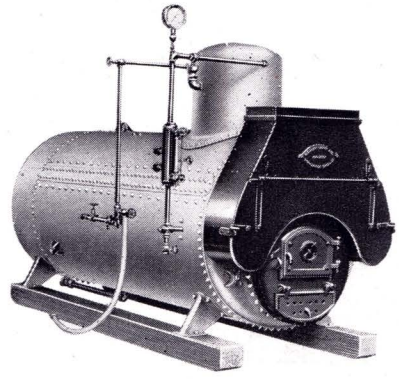
During all these years The James Leffel & Co. has specialized in the design and fabrication of many different types of High Grade Boilers and with this experience the Company decided to specialize on the Scotch Marine Type of Boiler, ranging in capacities from 6 H. P., up to 250 H. P., inclusive. Also, Vertical, High Pressure Boilers of both the Submerged Tube and Full Length Tube types in capacities from 2 H. P., up to and including 20 H. P. All constructed to comply fully with the A. S. M. E. Boiler Code and the many different State Codes. Nothing but the very best of material and workmanship is used in the fabrication of these Boilers. All parts of these Boilers are of rugged construction throughout and of special metals best suited for the duties required.

The basic principles of the Scotch Marine Type of Boiler are as follows: It is a self-contained horizontal boiler with the fire box consisting of a cylindrical flue, encased within the outside boiler shell and running lengthwise of the boiler and surrounded with water. Above and around the sides of the fire box flue is a series of fire tubes running lengthwise of the boiler, parallel with the fire box and also surrounded with water. The fire and heat are required to pass horizontally through the fire box, surrounded with water, through the combustion chamber to the rear end, and then return through the fire tubes, surrounded with water, to the smoke stack or chimney, located on the fire door end of the boiler.

By thus compelling the fire and heat to pass through the boiler twice in a horizontal direction and through passageways, surrounded with water, every opportunity is afforded the water in the boiler to absorb the heat from the fuel.

Utilizing the advantages of these basic principles of the Scotch Marine Type, the Leffel Engineers designed many new and important features in building the **Modern** Leffel Scotch Marine Type (Internally Fired, Return Tubular) Portable Boiler, which accounts for the extra high economy and efficiency, as well as the splendid steaming qualities of this boiler.





A Leffel Boiler Designed Especially for Your Particular Line of Industry

If the Power or Heating Plant Engineer should write his own specifications for an **ideal boiler** especially designed for his use to meet his local conditions, and if he should consider very carefully the work the boiler was to perform and all details on through to the ultimate cost, his specifications would probably include the following:

Important Features of the Leffel Scotch Marine Boiler

Self Contained, Portable.
Easily and quickly installed.
Quick and rapid steamer.
Low cost of fuel per pound of water evaporated.
Largest quantity of steam for a given size boiler.
The least floor space and head room for the Boiler's rated capacity.
As nearly smokeless as any Boiler.
Easy to fire and easy to regulate by inexperienced help.
Easy to clean and to keep clean.
No pockets or surface to collect scale or sediment, that will be difficult to clean.
Every horizontal surface cylindrical.
Not more than two vertical flat water surfaces.
No flat surfaces around the fire box or combustion chamber.
No external brick work or expensive masonry setting.
Utmost safety with largest overload capacity.
Grate Bars and Bridge Wall easily replaceable.
Lowest cost for maintenance, repairs and depreciation.

In addition, he would want to know about the reputation and financial responsibility of the manufacturer. He would want reports from users of said boilers so he may judge how it is adapted to his particular line of work, and to learn about the service rendered by the manufacturer after the boiler is installed.

All of the above essential features as well as many more are to be found in the Leffel Internally Fired, Return Tubular, or Scotch Marine Type Portable Boilers.

In the following pages an earnest and honest effort is made to faithfully and fully illustrate and describe not only these Boilers, but the Steam Engines, as now built, and furnished by this Company. Proper consideration is, therefore, requested of the information given, that there be a satisfactory understanding and appreciation of some of the distinguishing merits of this work. In their design and construction are embodied the results of over 78 years experience in building and furnishing engines and boilers for manufacturing plants; creameries and milk handling plants; laundries; cleaning and dyeing plants; hotels; office buildings; greenhouses; canners; bottlers and packers; ice cream plants; bakeries; saw mills; feed mills and many other lines.

While the illustrations and descriptions herein faithfully portray the Boilers and Engines as now built by this Company, and embody what is considered best practice at this time, yet, it is the purpose and policy of this company to keep fully abreast of the times. Should changing conditions suggest desirable improvements the right is reserved to make such alterations or changes in the construction or attachments as may be deemed best.

Cable Address:
"Leffel, Springfield, Ohio."
Codes Used:

Lieber's Standard.
Lieber's Five Letter American.
Western Union.
Western Union Five Letter Edition.
Engineering with Supplement.
A. B. C. 4th and 5th Edition.
A. B. C. 5th Edition Improved.
Bentley's Complete Phrase Code.
Business.
Leffel's Private.

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Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

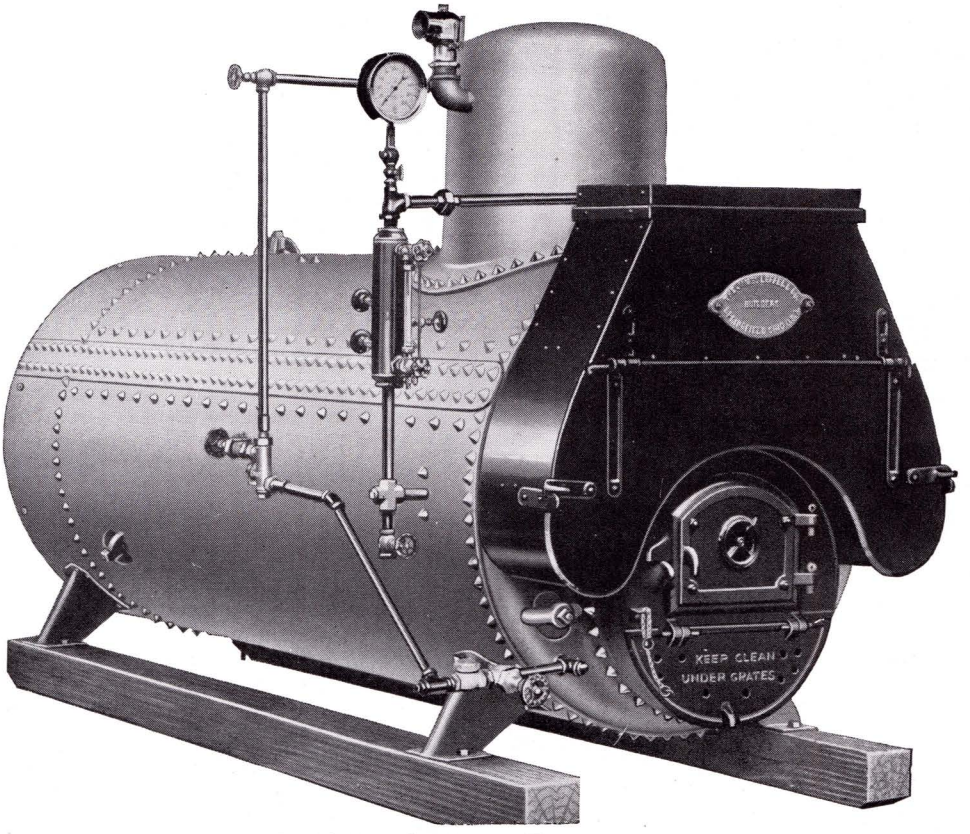


Fig. 60—Showing 30 H.P. Leffel Scotch Marine Type Boiler With All Fittings in Place.

Leffel Scotch Marine Type Boilers are made in eighteen sizes from 6 H.P. to 250 H.P. inclusive. They are unquestionably ideal for all industries requiring a powerful, economical, quick firing, and rapid steaming boiler that can be operated in a small space, with minimum attention and expense.

Portable—Quickly Installed

The modern Leffel Horizontal Internally Fired Return Tubular or Scotch Marine Type Boiler is entirely self-contained and complete with all fittings. From four to six heavy steel legs or brackets, according to the size of the boiler, are riveted securely to the lower portion of the boiler shell and the entire assembly is then mounted on skids. Thus the boiler is easily portable for shipping and convenient handling with rollers and crowbar. It can be readily set in place and put in service in the quickest time, with the least trouble and expense.

No Expensive Setting Required

The fire box is contained within the boiler itself, so that no expensive masonry setting is necessary. It is recommended, however, that brick or concrete piers be placed under the legs to maintain a level setting and at the same time raise the boiler a little higher from the floor for convenience in cleaning and caring for it. (See Fig. 75 on page 15.)

Not a Part of Real Estate

A boiler mounted in this manner is always portable and does not become a permanent part of the real estate, as is the case with many other types of boiler installations. It can be readily placed on skids again and moved, if desired.

No External Brick Work

A brick or masonry setting as required with the Horizontal Tubular Stationary, modifications of the Locomotive, and some other types of boilers, simply increases the cost of the boiler, requires much larger space and adds nothing to the stability or service. Should it be necessary to move the power plant, containing these other types of boilers, it would mean a loss of time and additional expense. The purchaser must

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

provide a suitable foundation for the brick walls, buy the necessary fire brick, clay, cement, lime etc., and pay the necessary labor to set this Stationary Boiler in brick work. In most cases the expense for materials and labor, for this type of setting, added to the first cost of the cheaper boiler, will amount to more than the cost of the Leffel Scotch Marine Boiler completely installed and ready to work.

In the case of external brick set fire boxes, the brick walls absorb and radiate heat, which means a loss of efficiency. They are apt to crack and allow air to infiltrate into the fire box, interfering with and making it difficult to regulate proper combustion. This seriously impairs the efficiency and entails expensive repairs. In a Leffel Scotch Marine Boiler very high efficiency is easily maintained without any of this trouble or expense for repairs because the fire box is contained within the outer boiler shell and surrounded by water, so that all air entering it can be exactly regulated by drafts in the fire box front.

Best for Intermittent Service

The Leffel Boiler is also by far the most desirable for intermittent service, or where the boiler is fired only during part of the year, such as in the Canning Industry or for heating greenhouses or apartment buildings, because other types of boilers will deteriorate much more rapidly if allowed to stand idle.

Less Floor Space is Required

The Leffel is more powerful than other types of boilers of the same size, because of its particular construction, with its properly proportioned and distributed heat absorbing surfaces and its self-contained fire box, without any external brick work. This means that it will occupy very much less space than any other type of boiler of the same rated capacity.

For instance, a 100 H.P. Leffel Scotch Marine Boiler will deliver more power on less fuel than a 100 H.P. brick set tubular boiler. The brick set boiler will occupy 46% more floor space and 23% more head room.

This is an important factor to consider, because in many plants where boiler space is limited, an increased amount of steam can be obtained from the same space or the same amount of steam from a smaller space by installing a Leffel Scotch Marine Boiler.

A vertical Boiler of course will take much less floor space and the first cost will be less, but on the other hand, it will require an excessive amount of head room. It will use about 30% to 50% more fuel; it is hard to keep clean and it will not last nearly so long as the Leffel Scotch Marine type.

A Long Fire Box with Ample Grate Area

The furnace of the Leffel Boiler is designed to promote complete combustion of all fuels.

It is a large cylinder of boiler plate extending the full length of the boiler and entirely surrounded by water so as to give maximum heat absorbing surface in contact with the heat and water for its full length. This provides a long and ample grate area for efficient firing.

There are no flat or oval surfaces around the top, bottom or sides of the fire box which would require a lot of stay rods or bolts to strengthen an otherwise weak surface, or to work loose, due to rapid expansion or contraction, or which would be difficult to clean or keep clean.

There are no fire brick sides in the Leffel Fire Box to absorb or radiate heat, or to leak air into the fire and interfere with efficient combustion, or to work loose or burn out and require expensive replacement, or to cause the outer shell to buckle or become loose, burn out or leak air into the fire.

The long, large cylindrical fire box of the Leffel Boiler, providing direct radiation of heat to the water throughout its entire circumference is the most efficient, strongest and most durable of all, free from fire brick losses, leakage and infiltration of air.

The grates are of simple durable design, supported on suitable cross bearers from the fire box door to the heavy cast iron bridge wall. The entire fire box front is easily removed allowing free access to the interior of the fire box when desired. The grate bars and bearers can be removed and replaced through the fire door opening.

Internally Fired

Being internally fired there is no possible chance for air to leak into the fire box to reduce the efficiency of combustion. The fire box, ash pit, and return fire tubes are entirely surrounded by water, every possible heat unit is made to do its full duty because every radiating surface is in direct contact with the water.

There are no dead radiating surfaces or fire box losses as in the Stationary Tubular or modification of the Locomotive Type Boilers.

Sediment and Loose Scale

Most all water contains a certain amount of lime, and more or less mud or sediment which is precipitated if

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

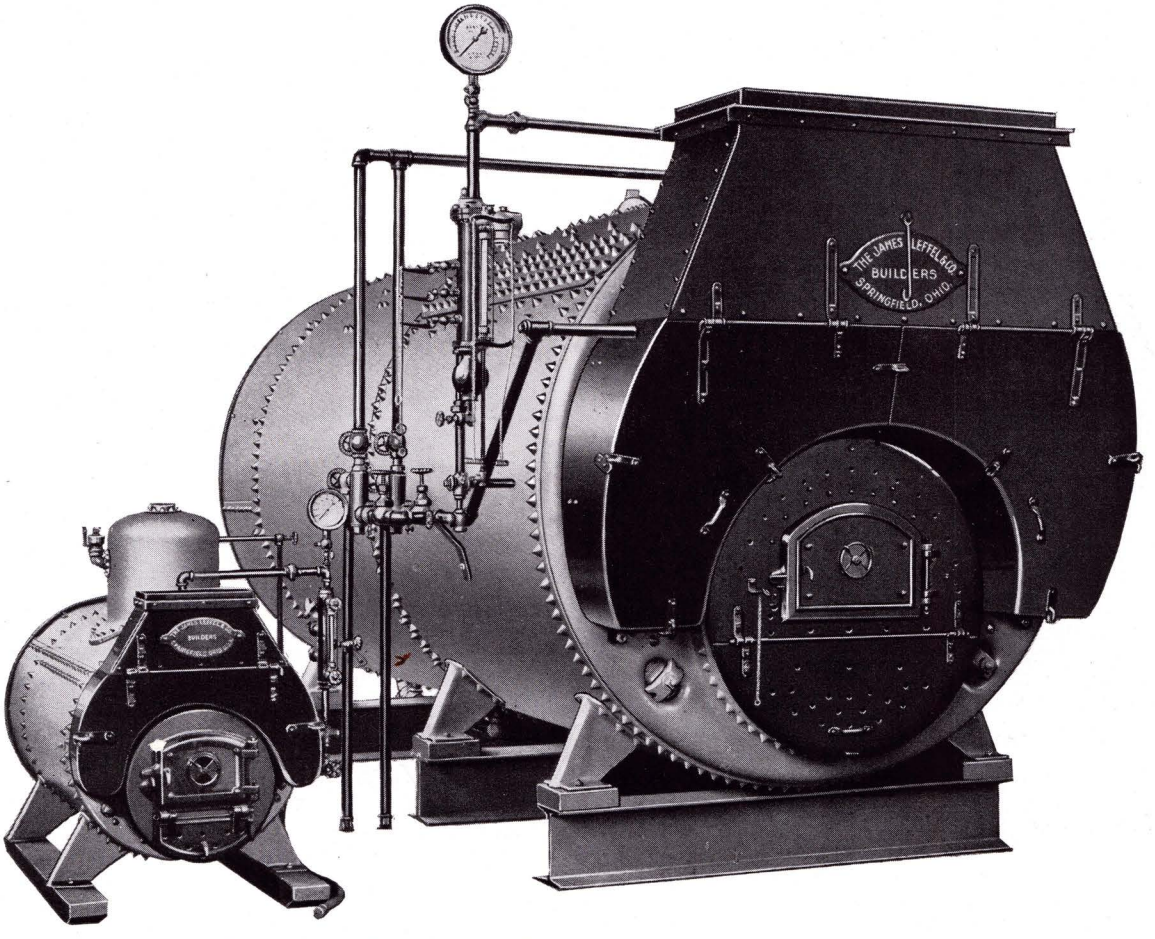


Fig. 61—6 H. P. and 200 H. P. Leffel Scotch Marine Type Boilers

The 200 H.P. Boiler is shown mounted on steel "I" beams and equipped with Automatic High and Low Water Alarm Column. Regular Mounting is on Wooden Skids and Steel Beams are Special

the water is boiled. This will deposit rapidly on flat surfaces or inaccessible pockets and if allowed to accumulate will exclude the water from those portions causing them to become overheated and blister, bulge or loosen rivets and leak.

In the Leffel Boiler there are no such flat surfaces or pockets. Figure 62, page 6, shows that all the horizontal surfaces are circular in shape so that scale and sediment have a decided tendency to slide off and settle to the bottom of the boiler below the ash pit from where they can be removed easily.

No Fire Brick Lining in Fire Box

In the Leffel Boiler there is no fire brick lining in the fire box to absorb heat or prevent radiation, or to work loose and allow air to filter into the fire and prevent proper combustion, or to require expensive and inconvenient replacement. The Fire Box, grates and drafts are so arranged as to promote complete combustion and the direct absorption of the greatest amount of heat to the water. With reasonable care in operation this fire box is good for the life of the Boiler without replacement or expensive repairs.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

Fig. 62—Cross Section Showing Interior View from the Front.

Large Full Length Return Fire Tubes

No Return Fire Tube in the Leffel Scotch Marine Boiler is less than 3 inches in diameter and all of these Fire Tubes extend the full length of the boiler from the combustion chamber in the rear to the smoke breeching in front. This gives a large efficient radiating surface to transfer every possible heat unit to the water and at the same time provides a tube large enough to clean easily and keep clean without danger of becoming clogged with the soot or ashes.

Fire Tubes and Fire Box Completely Submerged

The reason for the high steam producing efficiency of the Leffel Scotch Marine Boilers is clearly illustrated in Fig. 62. Fire Tubes are arranged on each side and above the Fire Box so that at every point the water is divided into small cross sections exposed to direct radiation from the hot gases of combustion. Even the heat from the ashes is utilized by the surrounding water. Note how the firebox and horizontal return tubes are entirely surrounded by water. Note the position of the grate, well below the center and with ¾ of the total volume of the water above it; note the position of the fire brick wall at the end of the combustion chamber with a direct unobstructed passage from the fire grates to the combustion chamber; also note the heavy construction and strongly riveted joints.

Removable Bridge Wall

Particular attention is called to the illustration, Fig. 63, showing the improved construction of the Removable Cast Iron Bridge Wall. Three angle lugs are securely riveted to the inside of the fire box. The bottom lug fits thru a slot in the lower web of the heavy Bridge Wall Casting, holding it in position, while the wall is held against the two side lugs by the grate bearers in front. Thus the new Bridge Wall as now furnished in all Leffel Scotch Marine Boilers can be removed or replaced easily at any time and there are no bolts or rivets to remove and replace. The top of the Bridge Wall above the grates, is protected from the intense heat of combustion by fire brick properly laid in fire clay cement at the factory. This type of bridge wall construction facilitates and makes possible more complete combustion of the fuel than with any other type of construction in a Scotch Marine Boiler.

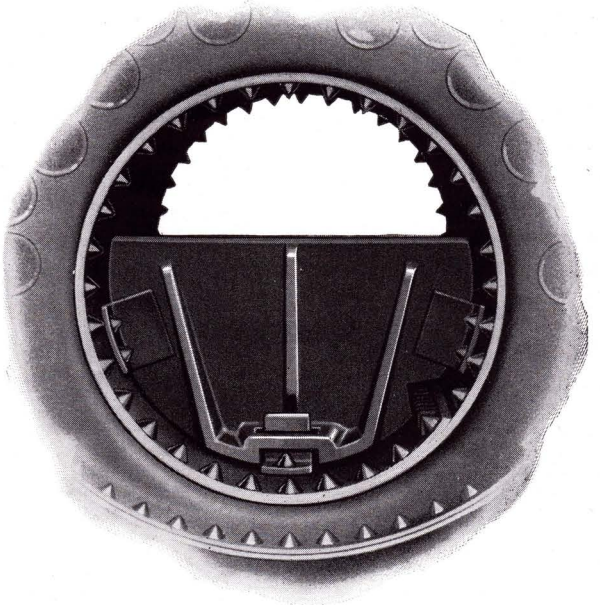


Fig. 63—Showing the Removable Bridge Wall.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

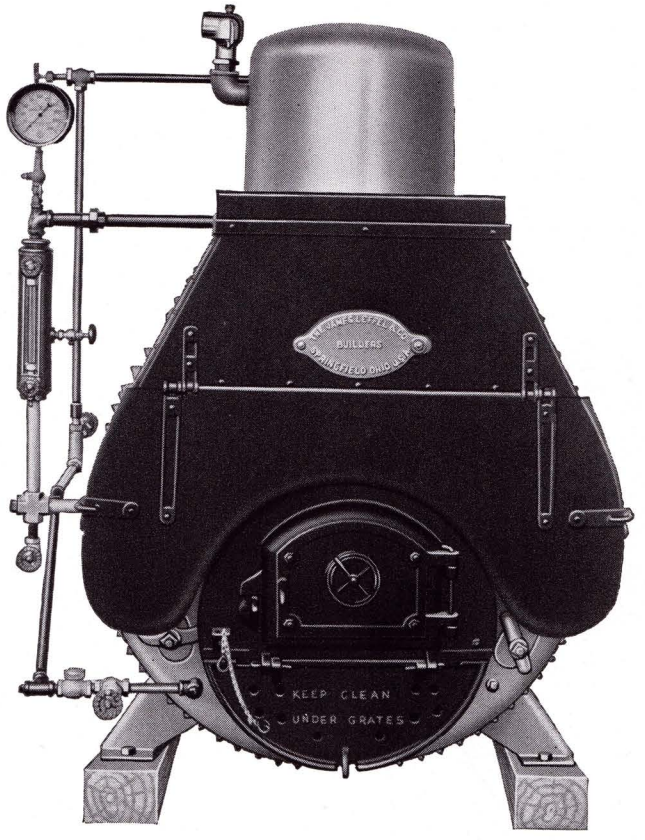


Fig. 64—Showing Front End with All Fittings Properly Assembled.

Smoke Breeching

The Smoke Breeching located on the front end permits efficient draft through all of the tubes. It is made of heavy sheet steel symmetrically formed and fitted with a rectangular shaped smoke stack nozzle. The lower portion is covered by a hinged door, which, when opened, allows free access to all of the tubes for cleaning. This is a single door on all of the smaller sizes, but on all 40 H. P. and larger sizes it is made in two parts, as a convenience in being able to clean half of the tubes at a time while the boiler is in operation with less disturbance to combustion.

Fittings May Be Placed on Either Side

Leffel Boilers are tapped on both sides so that the fittings, injector, water gauge, pressure gauge, etc., may be placed on either side, in order to accommodate the boiler to the most convenient space or setting in reference to other equipment or space available.

All pipe connections are on the outside, away from the hot fire where they are accessible and easily seen for inspection or adjustment.

Fire Door

The Fire Door is of the proper size and correctly placed to facilitate easy and rapid firing, with the minimum combustion disturbance. It is a substantial casting with inner fire plate lining and air space between to protect it from excessive heat.

Easy to Clean and Keep Clean

The high efficiency of The Leffel Boiler can be maintained for many years because every part is accessible so it can be easily cleaned and kept clean.

The ash pit door is wide and conveniently arranged for the removal of ashes.

The large clean-out opening at the rear makes it easy to remove any ashes which may accumulate back of the bridge wall and in the combustion chamber.

The smoke breeching door permits the tubes to be thoroughly cleaned even while the boiler is in operation.

The fire box front itself may be easily removed, allowing ready access to the entire interior of the fire box and ash pit.

Hand-holes and man-holes are conveniently arranged at the proper place in front, sides, bottom and top for effectively cleaning the water chambers. Mud and free scale trapped at the bottom of the boiler can be freely flushed out through the blow-off pipe and bottom hand holes.

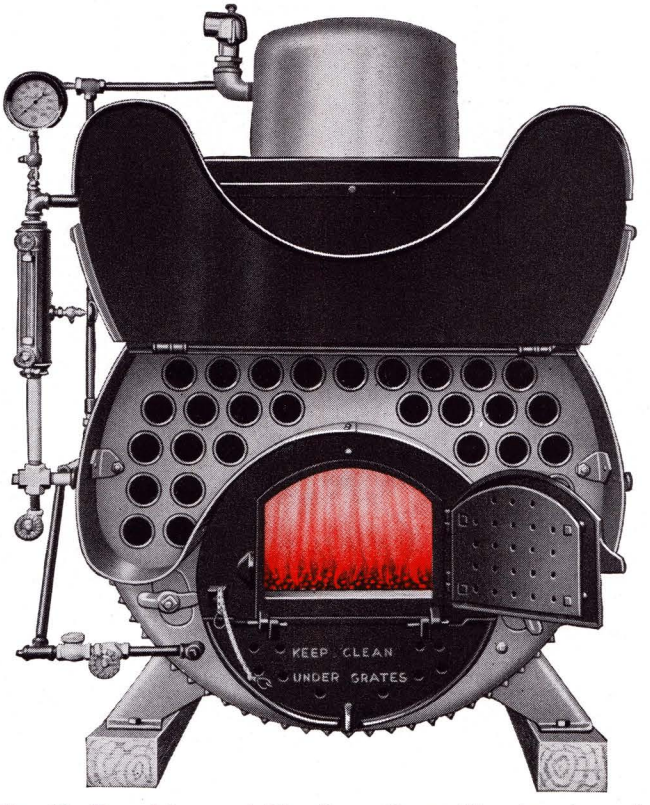
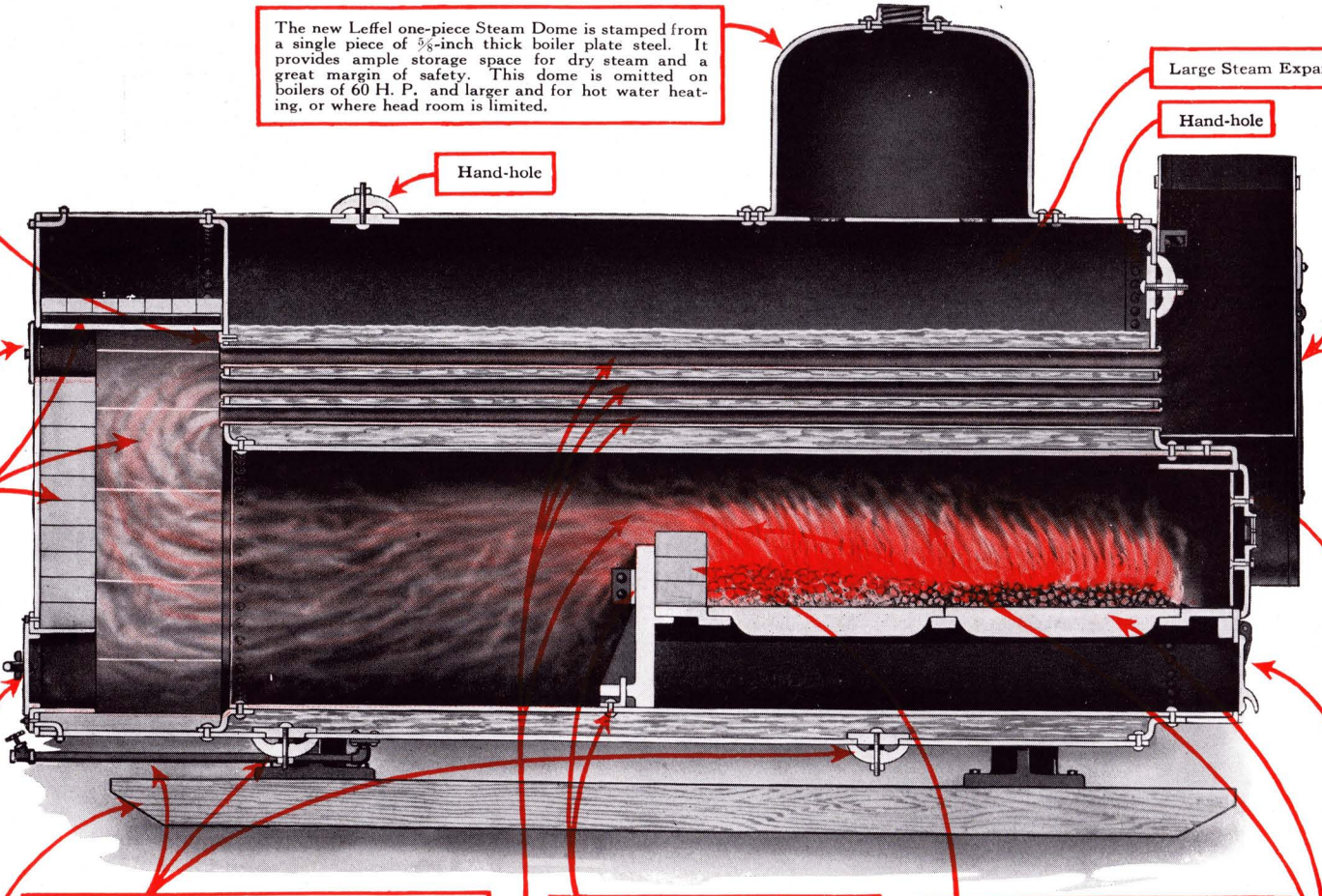


Fig. 65—Breeching and Fire Door Open, Showing Accessibility to the Tubes and Fire Box.

Leffel Internally Fired, Return Tubular Scotch Marine Type Portable Boiler

Built to Comply with All State Boiler Laws and the A. S. M. E. Code

Fig. 66—Sectional View of 40 H. P. and Smaller Sizes



The new Leffel one-piece Steam Dome is stamped from a single piece of 5/8-inch thick boiler plate steel. It provides ample storage space for dry steam and a great margin of safety. This dome is omitted on boilers of 60 H. P. and larger and for hot water heating, or where head room is limited.

Large Steam Expansion Space.

Hand-hole

Hand-hole

This Fusible Safety-Plug of soft metal melts when the water gets too low, permitting steam to escape and giving warning before damage can occur. Easily replaced through large hand-hole, with special socket wrench furnished with boiler.

ThisBreechingSmoke Door opens wide to give access to flues, which may be cleaned while the boiler is in operation. This feature of Leffel Boilers does away with much bother and inconvenience—a great saving in time and labor, promoting the general efficiency of Leffel Boilers.

Improved heavy Fire Brick lining in rear end of every boiler, protects shell, prevents radiation of heat and increases fuel economy and efficiency. This lining is correctly laid in in fire brick cement before boiler leaves factory.

Extra large Fire Box Door is placed at exactly the right height for proper fuel handling. This makes firing easy and saves unnecessary exertion.

New type large Rear Door permits easy cleaning, giving free access to rear end of combustion chamber for quick removal of soot, ashes, or other accumulated matter, and making for greatest efficiency.

Large Ash Pit Door permits easy removal of ashes. Hand-holes in head on either side of firebox and in shell are provided for easy cleaning. Nothing has been overlooked. Leffel boilers are as convenient to care for as they are economical.

There are no pockets or inaccessible flat surfaces to accumulate sediment or scale. All horizontal surfaces are round and the sediment and scale settle to the bottom where large hand-holes and blow-off pipe are provided for cleaning. Hand-holes in top, sides and head also provided according to size of boiler.

New Bridge Wall fits against side lugs and over bottom lug riveted to inside of fire box; it lifts out easily and quickly for replacement and new bridge is set in same way, without bolts or rivets.

Fire Brick Wall on top of dead plate at rear of grates protects and prolongs life of the bridge, an important factor in the low maintenance cost and splendid service of Leffel Scotch Marine Boilers.

Wooden Skids are provided with every boiler. A brick set boiler will rust out more rapidly when not in use; there is no such heavy stand over loss with a Leffel boiler. That is one reason why they last longer than other boilers. We recommend placing concrete piers under the legs of the boiler.

The hot gases of combustion must travel twice the entire length of the boiler through water-surrounded passageways; the fire box, tubes, and even the ash pit are entirely surrounded by water. Every possible heat unit is extracted from the fuel and utilized to make steam because the heating surface in all Leffel Boilers is properly proportioned and located. Is it any wonder that these boilers frequently use 20% to 40% less fuel than other types? This means not only a saving in fuel cost but also a saving in cost of handling less fuel and correspondingly less ashes.

The Fire Box extends the full length of the boiler giving much more heating surface exposed to the direct fire than in other types. This long fire box allows the hot coals to be pushed to the rear and fresh coal to be placed near the door. The green coal gives off gases which contain potential heat, and these gases must pass over the glowing coals where they are converted into heat and the smoke is almost completely consumed.

Extra heavy Grates with Bearers are now furnished in every Leffel Boiler. Suitable for burning either coal or wood.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

Only Two Vertical Flat Surfaces

There should be no more vertical or horizontal flat surfaces in a boiler than absolutely necessary because they require an excessive amount of bracing to afford necessary strength; or they may form pockets or surfaces to accumulate scale or sediment which would be inaccessible and difficult to keep clean.

So in the Leffel Scotch Marine Boiler there are only two flat surfaces in contact with the water—namely, the two vertical ends or tube heads and no boiler can be made with any less. These tube heads being vertical, do not readily accumulate sediment and they are amply braced for utmost safety by the large number of fire tubes and with diagonal stay rods in the large sizes.

All Side Surfaces Cylindrical—No Stay Rods or Bolts

All side surfaces in the Leffel Boiler—outer shell, tubes and internal fire box, are made with perfect circular circumference because this shape is self-bracing and assures the greatest possible strength without braces or cross stay rods of any kind. There are no horizontal flat surfaces.

The oval and flat side, top or bottom surfaces in modifications of the Locomotive and other types of boilers require extensive stay rods and cross bolts to strengthen these surfaces to keep them from bulging. The unequal expansion and contraction of the inner and outer plates is apt to cause the rods to work loose and leak as well as impairing the safety. Such boiler construction generally forms inaccessible pockets or surfaces to gather sediment or scale and which are difficult to clean.

Large Combustion Chamber

The combustion chamber of the Leffel Boiler is large and properly arranged for complete and efficient combustion. Starting from the Bridge Wall and extending back to the rear end, it comprises nearly one-half the entire length of the boiler allowing plenty of travel and space for the gases to mix with air for proper combustion.

There are no obstructions or small tubes in this combustion chamber for the burning gases to pass through which would have a tendency to slow down the process of combustion by prematurely reducing the temperature or by retarding the draft.

Fire Brick Lining Aids Combustion

The rear end or secondary combustion chamber is provided with a heavy fire brick lining carefully and properly placed in fire clay cement at the factory.

This lining in the rear end becomes intensely hot, thereby facilitating secondary combustion in much the same way as the baffle plate of an oil burner in an ordinary furnace, or the hot tube or bulb in a Diesel Engine.

The hot fire brick in the rear tends to maintain a more uniform high temperature at the peak of combustion, breaking down and consuming any solid particle of carbon or volatile gases that may have reached this point. Thus, the hot gases that pass forward through the fire tubes to the smoke pipe are the products of complete combustion. In this state very little if any soot will be deposited by the cooling action of radiation to the water as it passes through the tubes.

This lining also forms a perfect insulation for the rear boiler shell and end plate, preventing loss of efficiency by useless radiation. The Steel End Plate effectively seals the rear end of the boiler, preventing any infiltration of cold air which would reduce the efficiency.

Makes Fuel Do Double Duty

The flames and hot gases of combustion play directly on the inner submerged fire box of the boiler for its full length—then as combustion gains force and is completed in the secondary combustion chamber—the intensely hot gases pass up and back through horizontal submerged tubes to the smoke pipe.

As the hot gases travel **twice** the full length of the boiler horizontally through water surrounded passageways, the fuel thus does double duty, every single heat unit being forced to do its utmost to produce steam.

Smokeless—No Escaping Sparks

Smoke or free carbon is a product of incomplete combustion.

Introduce a piece of cold metal or glass at different points in the flame of a candle and note the heavy deposit of carbon at some positions, showing that the cold object prematurely reduced the temperature of combustion. At other positions there will be scarcely any deposit and the metal will heat more rapidly, showing that rapid radiation after combustion is complete will not precipitate smoke or free carbon.

When properly fired the Leffel Scotch Marine Boiler is practically smokeless, because the radiation is properly arranged and combustion is completed before the hot gases reach the smoke stack. Fire risk is reduced to the minimum, for the same reason, because there are no sparks escaping through the smoke stack.

Radiating Surfaces

One of the chief factors contributing to the high efficiency of the Leffel Scotch Marine Boiler is the scientifically proportioned, arranged and distributed radiating or heat absorbing surfaces, so as to utilize all of the available heat without prematurely reducing the temperature and efficiency of combustion.

It is not the total radiating or heating surface in a boiler that determines its efficiency but rather the amount of effective heating surfaces as found in Leffel Scotch Marine Boilers.

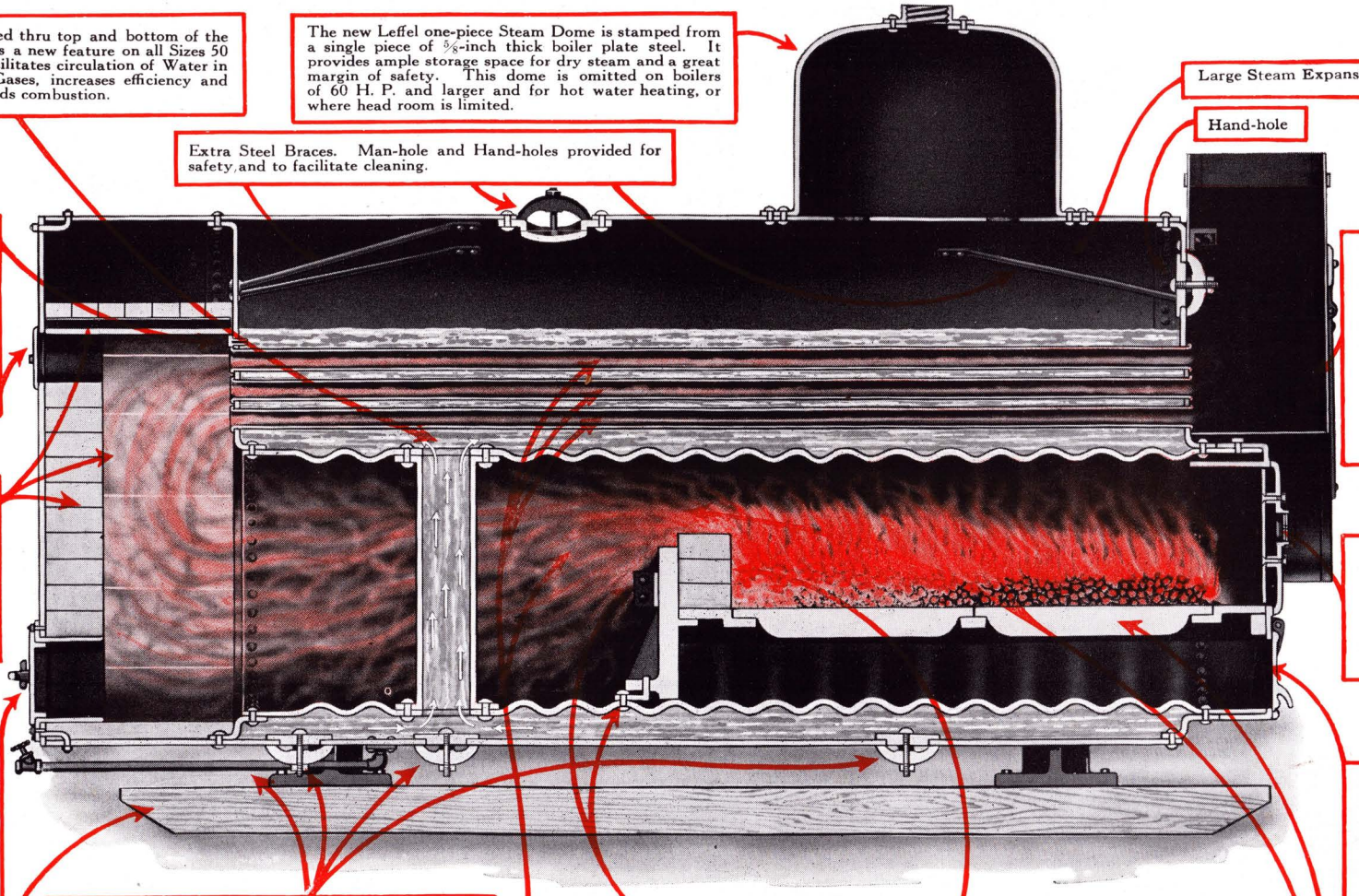
No Experienced Engineer Required

Many times, in a small plant, the duties of Engineer are handled by some one not versed in all the technical information needed by a complicated boiler—and so Leffel Boilers are simply designed, easy to understand and give perfect service even when fired by an amateur. Thus, the one who fires the boiler may also perform many other duties.

Leffel Internally Fired, Return Tubular, Scotch Marine Type Portable Boiler

Built to Comply with All State Boiler Laws and the A. S. M. E. Code

Fig. 67—Sectional View of 50 H. P. and Larger Sizes of Leffel Laundry and Cleaning Plant Boilers



Circulating Tube welded thru top and bottom of the corrugated Fire Box is a new feature on all Sizes 50 H. P. and larger. Facilitates circulation of Water in direct path of Hot Gases, increases efficiency and quick steaming, also aids combustion.

The new Leffel one-piece Steam Dome is stamped from a single piece of 5/8-inch thick boiler plate steel. It provides ample storage space for dry steam and a great margin of safety. This dome is omitted on boilers of 60 H. P. and larger and for hot water heating, or where head room is limited.

Large Steam Expansion Space.

Hand-hole

Extra Steel Braces. Man-hole and Hand-holes provided for safety and to facilitate cleaning.

This Fusible Safety-Plug of soft metal melts when the water gets too low, permitting steam to escape and giving warning before damage can occur. Easily replaced through large hand-hole, with special socket wrench furnished with boiler.

This Breeching Smoke Door opens wide to give access to flues, which may be cleaned while the boiler is in operation. This feature of Leffel Boilers does away with much bother and inconvenience—a great saving in time and labor, promoting the general efficiency of Leffel Boilers.

Improved heavy Fire Brick lining in rear end of every boiler, protects shell, prevents radiation of heat and increases fuel economy and efficiency. This lining is correctly laid in in fire brick cement before boiler leaves factory.

Extra large Fire Box Door is placed at exactly the right height for proper fuel handling. This makes firing easy and saves unnecessary exertion.

New type large Rear Door permits easy cleaning, giving free access to rear end of combustion chamber for quick removal of soot, ashes, or other accumulated matter, and making for greatest efficiency.

Large Ash Pit Door permits easy removal of ashes. Hand-holes in head on either side of firebox and in shell are provided for easy cleaning. Nothing has been overlooked. Leffel boilers are as convenient to care for as they are economical.

There are no pockets or inaccessible flat surfaces to accumulate sediment or scale. All horizontal surfaces are round and the sediment and scale settle to the bottom where large hand-holes and blow-off pipe are provided for cleaning. Hand-holes in top, sides and head also provided according to size of boiler.

New Bridge Wall fits against side lugs and over bottom lug riveted to inside of fire box; it lifts out easily and quickly for replacement and new bridge is set in same way, without bolts or rivets.

Fire Brick Wall on top of dead plate at rear of grates protects and prolongs life of the bridge, an important factor in the low maintenance cost and splendid service of Leffel Scotch Marine Boilers.

Wooden Skids are provided with every boiler. A brick set boiler will rust out more rapidly when not in use; there is no such heavy stand over loss with a Leffel boiler. That is one reason why they last longer than other boilers. We recommend placing concrete piers under the legs of the boiler.

The hot gases of combustion must travel twice the entire length of the boiler through water-surrounded passageways; the fire box, tubes, and even the ash pit are entirely surrounded by water. Every possible heat unit is extracted from the fuel and utilized to make steam because the heating surface in all Leffel Boilers is properly proportioned and located. Is it any wonder that these boilers frequently use 20% to 40% less fuel than other types? This means not only a saving in fuel cost but also a saving in cost of handling less fuel and correspondingly less ashes.

The Fire Box extends the full length of the boiler giving much more heating surface exposed to the direct fire than in other types. This long fire box allows the hot coals to be pushed to the rear and fresh coal to be placed near the door. The green coal gives off gases which contain potential heat, and these gases must pass over the glowing coals where they are converted into heat and the smoke is almost completely consumed.

Extra heavy Grates with Bearers are now furnished in every Leffel Boiler. Suitable for burning either coal or wood.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

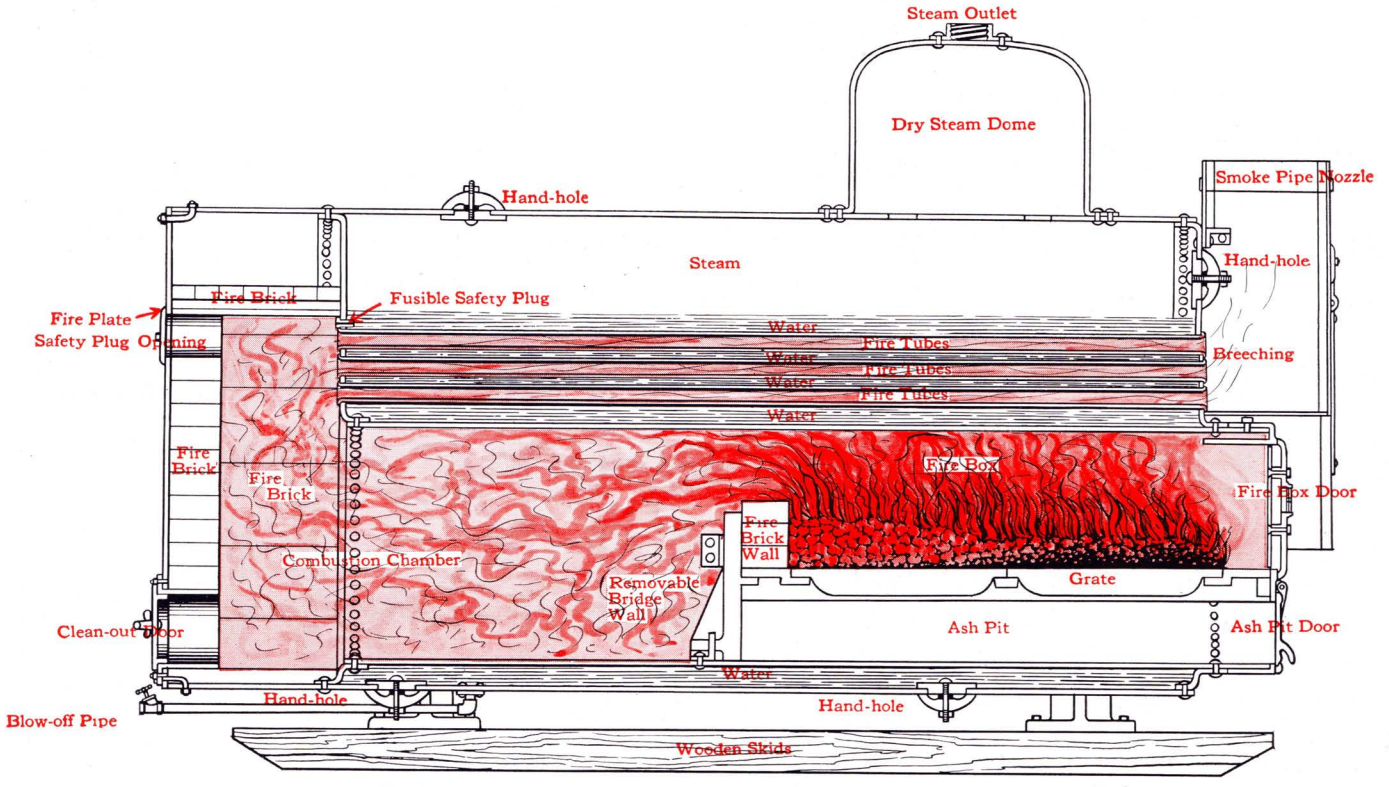


Fig. 68—Showing the Various Parts and Sturdy Construction of Leffel Scotch Marine Boilers.

Note Particularly the Large Grate Area, the Large Combustion Chamber with Unobstructed Passageway to the Secondary Combustion Chamber and back through the Fire Tubes.

Water Circulates Rapidly

The very rapid water circulation is obtained in The Leffel Boiler because the radiating surfaces of the fire box, ash pit, combustion chamber and fire tubes are so arranged and distributed that the water throughout the entire boiler is divided into small cross sections, in direct contact with a heated surface. There are no angular surfaces or dead pockets, this is clearly shown in Fig. 62, page 6 and Fig. 68 above.

Water Circulating Tube

On account of greater volume of water in the larger boilers, a Vertical Circulating Tube is placed in all sizes of 50 H. P. and larger as shown in Fig. 67, page 10.

This is a seamless tube 8 inches in diameter welded in the fire box shell, about one-third of the way back from the bridge wall. It is large enough to provide **direct vertical positive circulation** of water from beneath the fire box to the top of the boiler. It also adds considerable additional radiating surface in the direct path of the burning gases, but properly placed so that it will not interfere with efficienct combustion in the secondary combustion chamber. The positive circulation thus provided increases efficiency and very materially adds to the splendid steaming qualities of the boiler.

Sheet iron forms, shaped around the outside of the fire box, to help circulation, sometimes offered by others, are simply inefficient-make-shifts, adding nothing to the effective radiating or heating surface but tending to create columns of dead water back of them and they have no advantage over the circulating effect of water in contact with the circular surface of the fire box itself in the Leffel Boiler.

Large Reserve Capacity

Due to its particular construction, size of fire box and arrangement of heating surfaces, the Leffel Boiler, when properly fired either by hand or mechanically, will deliver much more than its steam rated capacity.

The larger sizes also have a very large reserve water and steam storage capacity which enables them to hold steam pressure, with a banked fire, over night very easily.

Quick, Splendid Steamer

It is easy to see from the cross section illustrations, that the water circulates rapidly and that ample draft regulation is provided so the rate of combustion may be properly controlled. All of this assures quick steaming capacity so that the Leffel Boiler will make steam faster than other types of boilers—it will get up a good head of steam more quickly, deliver a quantity of steam continuously and hold a good head of steam for a longer time, without excessive firing.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

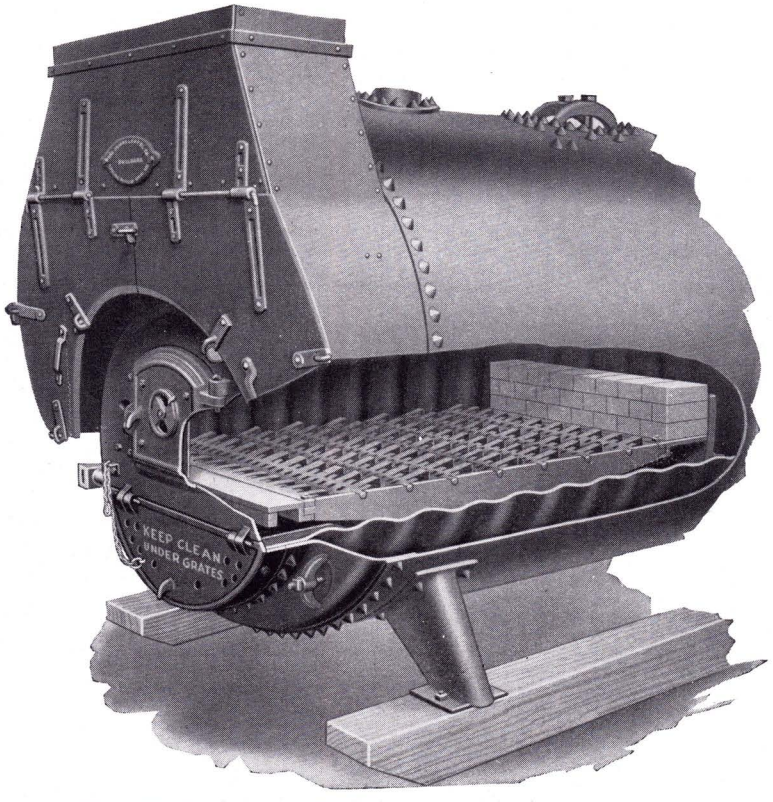


Fig. 69—Section of Furnace showing arrangement of Shaking and Dumping grates, with the Grates in partial dumping position.

Shaking and Dumping Grates

Shaking and Dumping Grates are now furnished regularly in all Leffel Scotch Marine Type Boilers of 60 H. P. and larger sizes. These grates are made in movable sections, which rock both ways, with a finger motion up and down, sifting out the fine ashes and breaking up and forcing out the clinkers. Air space is provided at both sides and ends of each interlocking finger. These are not only shaking grates, but also dumping grates, permitting the grate surface to be thoroughly cleaned without opening the fire door, thus saving time and fuel.

Every operation—sifting—shaking—dumping—is performed without opening the fire doors. Consequently there is no inrush of cold air to cool the fire or lower the steam pressure. A positive locking device holds the grate surface level when not being operated, so there is no danger of fingers projecting up into the fire to be burned off.

When specially ordered, Shaking Grates can be supplied in Boilers of 50 H. P. and smaller.

Corrugated Furnace

A Seamless Corrugated Furnace or Fire Box of homogeneous boiler plate is used in all Leffel Scotch Marine Type Boilers of 50 H. P. and larger sizes. This provides for unequal expansion and contraction without any danger of opening up any of the seams or causing undue strains which might occur in these larger sizes.

A plain riveted steel plate furnace is used for the fire box on all boilers of 40 H. P. and less.

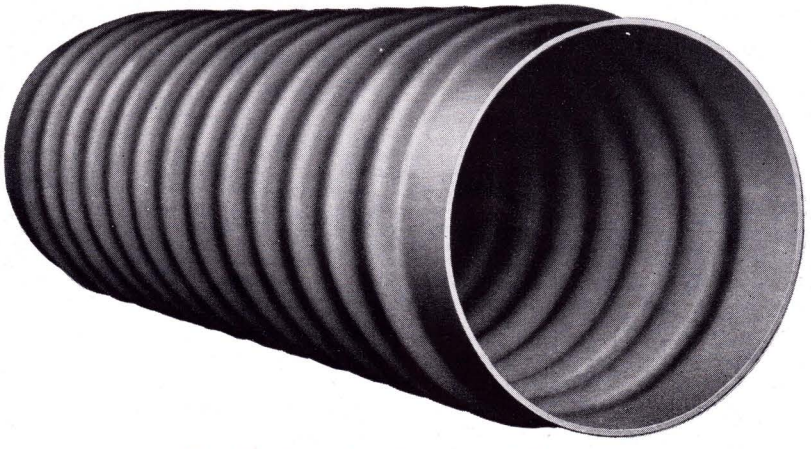


Fig. 70—Seamless Corrugated Furnace.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

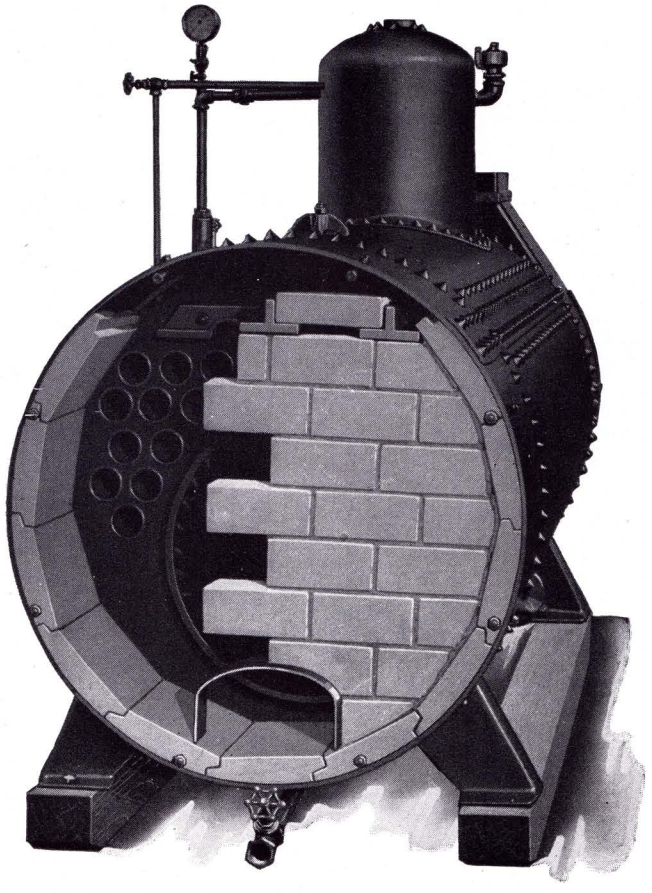


Fig. 71—Fire Brick Walls at Rear end Properly Put in Place at the Factory—Note the Large Clean-out Opening.

Rear Clean-out Door

Efficiency as well as the very life of the boiler depends on being kept clean. Dust and ashes will accumulate in the fire box back of the bridge wall and in the combustion chamber, and these can be very easily removed through the large clean-out opening provided in the rear end of every Leffel Boiler. The Leffel Fire Box and Combustion Chamber are freely accessible from end to end. There is no water back or other obstruction to make thorough cleaning difficult or impossible, as in some other makes of boilers.

Safety Fusible Plug

To prevent accidents that may result from water boiling down to the danger point Leffel Boilers are provided with a Safety Plug, inserted in the rear tube head. When water gets below the proper level the heat of the fire melts this plug, and water or steam is allowed to escape, warning the engineer before the boiler itself can be injured by lack of water.

As evidence of our desire to serve our customers well we send an extra plug with each boiler. This eliminates any necessity of a boiler being left out of commission while a new plug is being obtained.

A suitable capped opening in the rear head and brick wall, and a long socket wrench are provided so that the Fusible Safety Plug may be easily and conveniently removed or replaced at any time from the outside.

All Fire Brick Placed at Factory

Figures 71 and 72 show the rear end construction of the Leffel Scotch Marine Boilers. Fire Brick is placed above the grates to protect the cast iron bridge wall. The Secondary Combustion Chamber at the rear end is lined around the circumference, at the top, and the rear end by heavy fire brick to insulate the exposed extension of the outer boiler shell, the rear end plate and that portion of the rear tube head above the water area. This fire brick lining not only holds the heat in but is a positive aid to the secondary combustion.

The Leffel Boiler has all of the above required internal fire brick properly and carefully laid in fire clay cement at the factory before shipment. None of this fire brick or fire clay cement is required to be purchased and put in place by the customer as in many other makes of boilers.

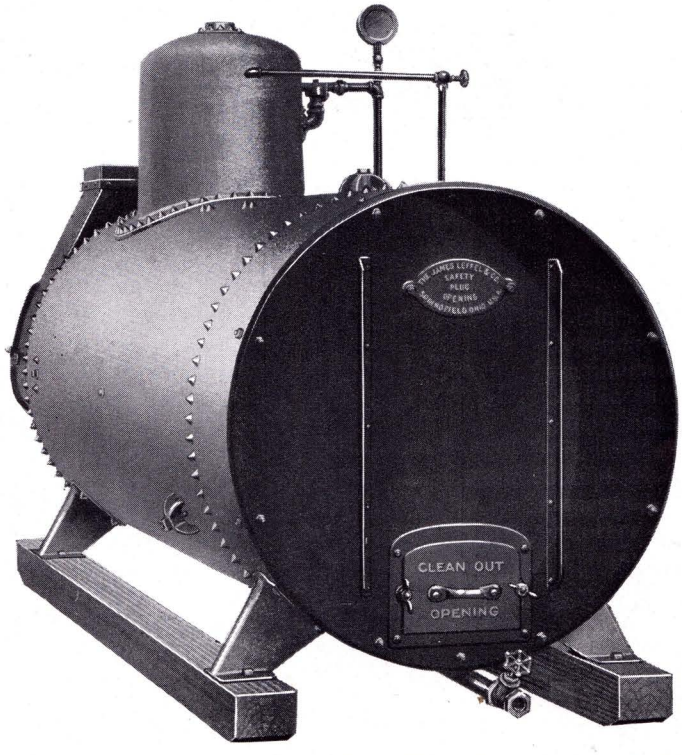


Fig. 72—Showing Removable Steel Plate Covering and Sealing the Rear End of the Boiler, with Clean-out Opening at the Bottom and Opening at the Top Allowing Access to the Safety Plug from the Outside.

Leffel Automatic Underfeed Stoker

Patented

For Internally Fired, Return Tubular, or Scotch Marine Type of Portable Boiler

See pages 25 and 26

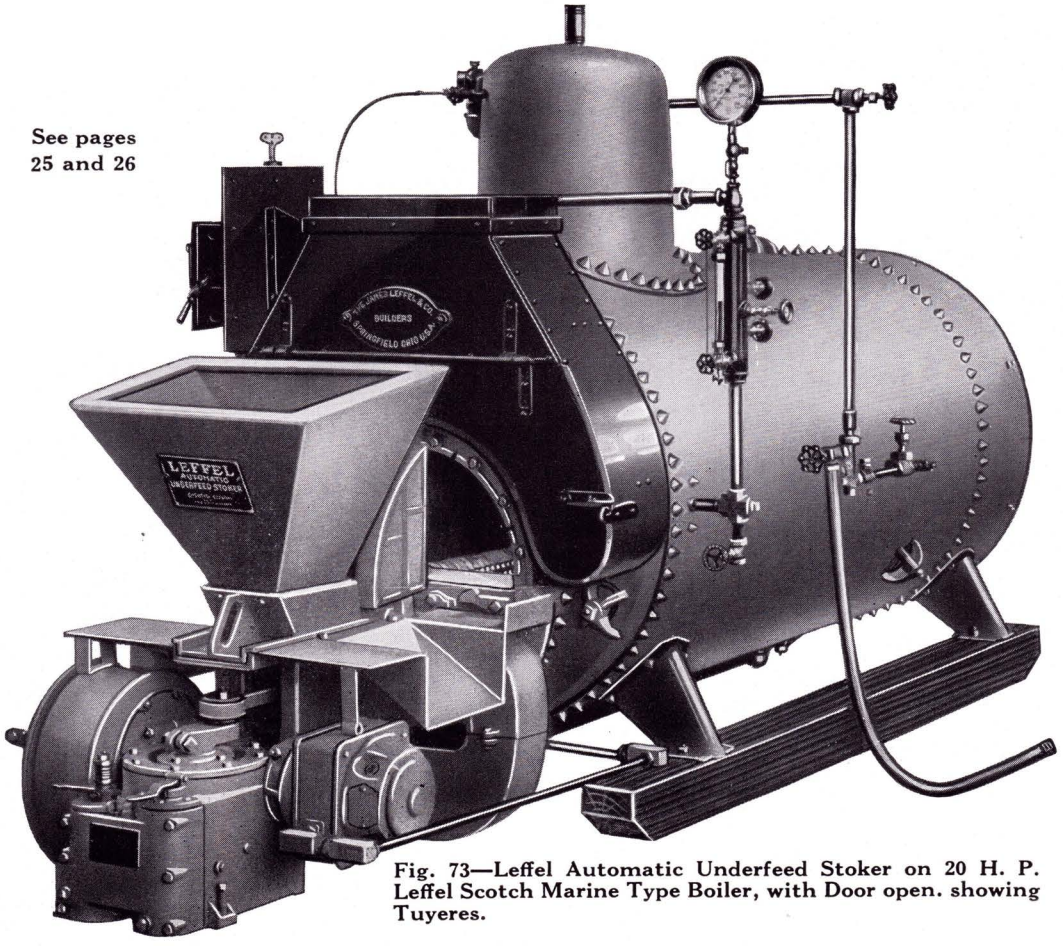


Fig. 73—Leffel Automatic Underfeed Stoker on 20 H. P. Leffel Scotch Marine Type Boiler, with Door open. showing Tuyeres.

Leffel Stokers are designed especially for the Internally Fired, Return Tubular, or Scotch Marine Type of Portable Boiler and incorporate many new features which are absolutely necessary to obtain first-class Stoker performance in boilers of this type.

The Leffel Automatic Underfeed Stoker, with 100% control of fuel and air, totally enclosed dust-proof gearing operating in an oil bath, automatic safety protection and compact unit construction, economizing on floor space and facilitating operation, establishes a new standard in Stoker construction and performance.

The Leffel Stoker is very convenient and simple to operate. It is of the motor-driven, safety-plunger, underfeed type, with adjustable air and fuel feed automatically controlled by steam pressure. Steam Turbine Drive can be supplied on special order in place of the standard Motor Drive equipment.

Automatic firing with forced draft automatically controlled produces more complete combustion with less ashes and no smoke. This enables the Leffel Scotch Marine Type Boiler to give continuous performance at high efficiency with less fuel and lower operating cost.

Your present Leffel Boiler can be equipped easily and quickly with a Leffel Automatic Stoker in any size from 15 H. P. to 250 H. P.

The complete Stoker Unit is assembled at the factory before shipment, ready for installation in any Leffel Scotch Marine Type Boiler now in use, by any good mechanic, as no field drilling is required.

In the construction of the Leffel Stoker no consideration of cost is permitted to supersede the requirement of quality. All material used is the most suitable obtainable for each particular purpose, and must pass a rigid inspection before entering into the construction of the Stoker.

A separate Bulletin will be sent on request. Please give necessary data, stating size of Boiler, inside diameter and length of fire box, also state current available, D. C. or A. C. Voltage, Phase and Cycles, to enable us to determine the proper installation.

Leffel Oil Burning Scotch Marine Type Boilers

Internally Fired Return Tubular, A. S. M. E. Code

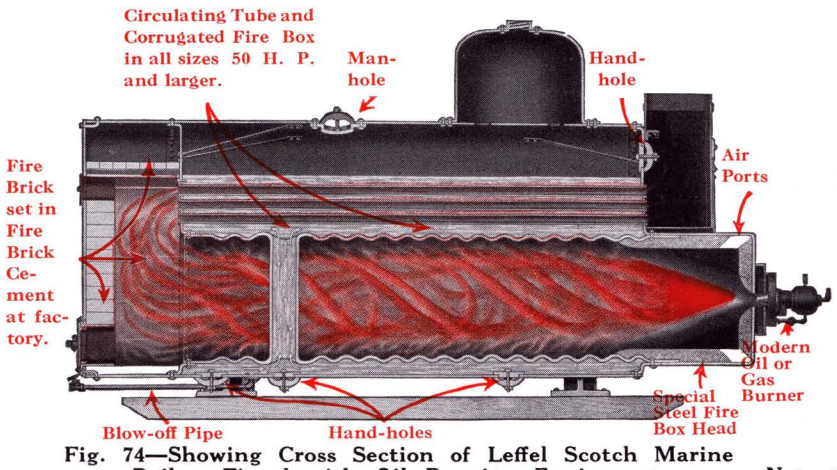

Circulating Tube and Corrugated Fire Box in all sizes 50 H. P. and larger.
Man-hole
Hand-hole
Air Ports
Fire Brick set in Fire Brick Cement at factory.
Modern Oil or Gas Burner
Special Steel Fire Box Head
Blow-off Pipe
Hand-holes

Fig. 74—Showing Cross Section of Leffel Scotch Marine Boiler, Fitted with Oil Burning Equipment.

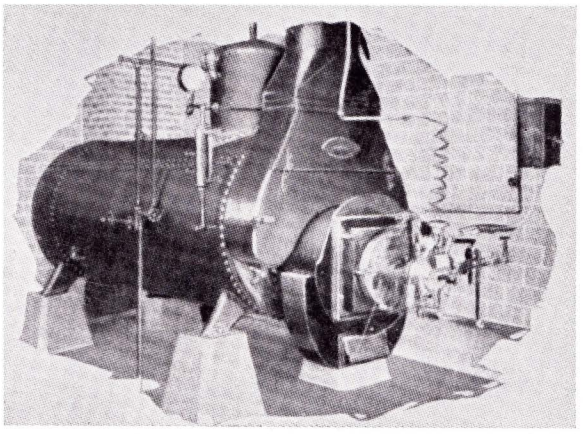


Fig. 75—Leffel Oil Burning Boiler Installation.

Note that concrete piers under the boiler legs are the only masonry setting suggested for a Leffel Scotch Marine Boiler.

All Leffel Boilers can be adapted for burning oil or gas, through the addition of simple efficient burners for handling these fuels

Figure 74 shows a modern Oil Burning Equipment installed in a Leffel Scotch Marine Boiler. This burner has an automatic pressure control for both oil and air to give high efficiency with great flexibility. The controller adjusts itself to maximum and minimum load requirements immediately and thus prevents large fluctuations in the steam pressure, always maintaining the correct amount and proportion of air and oil for complete combustion.

Any commercial grade of fuel oil may be burned without pre-heating. An underground oil storage tank should be used, with suitable strainer, gauge and valves.

In practically every city there is now a local Sales and Service Agency, fully competent to install either Oil or Gas burning equipment. Any Leffel Coal Burning Boiler can be readily changed to burn Oil or Gas.

When Gas is used as fuel a Gas Burner is used instead of the Oil Burner, and the arrangement in the fire box is practically the same as for burning Oil.

If it should be desired to use coal, wood, or other fuel the burners can be easily disconnected, the bridge wall, grates, fire brick and front end restored and the boiler is ready for use.

Leffel Wood Burning Scotch Marine Type Boilers

Internally Fired Return Tubular, A. S. M. E. Code

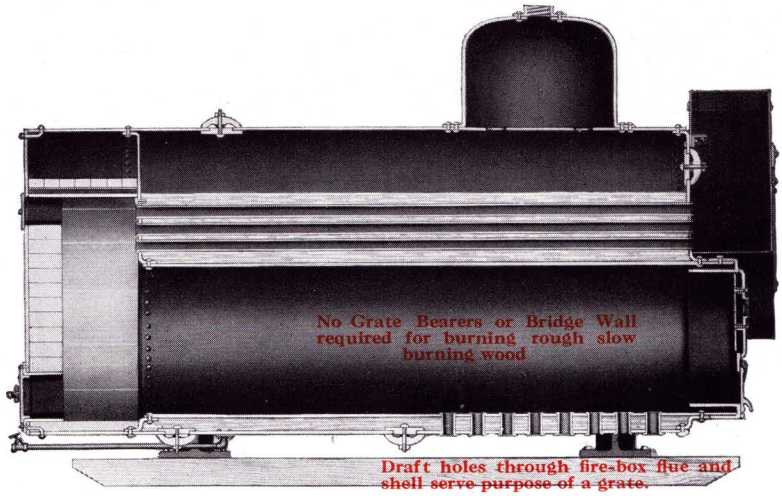

No Grate Bearers or Bridge Wall required for burning rough slow burning wood
Draft holes through fire-box flue and shell serve purpose of a grate.

Fig. 76—Sectional View of Leffel Scotch Marine Boiler, Equipped for Burning Wood.

Leffel Scotch Marine Boilers equipped for wood burning are splendidly adapted for use where wood is avaliable as the cheaper fuel. Wood that burns freely and is not too rough can be used with the regular grate equipment furnished with Leffel Scotch Marine Boilers. However, where rough wood that is not free burning is used, we recommend that Grates, Bearers and Bridge Wall be omitted and that a series of Draft Holes through the bottom of the fire box flue and shell be substituted. The long fire box permits burning long wood thus saving labor required in cutting to shorter lengths necessary for other boilers. The price of the boiler equipped either way is the same.

The draft holes serve the same purpose as the grates, allowing sufficient draft for proper combustion, and at the same time permitting the ashes to drop through.

When draft hole construction is used an extra ash box covering the draft holes and attached beneath boiler, can be furnished at additional cost. This ash box is fitted with a door for cleaning out the ashes and is adjustable for shutting off draft, if desired. The air tubes are rolled Beaded and Welded into furnace and shell.

Construction Details of Leffel Scotch Marine Type Boilers

Complete Equipment

Leffel Boilers are of especially strong, compact and substantial construction. Ample provision is made in the design to equalize the strains of expansion and contraction in all parts.

Every Leffel Boiler is shipped complete with all necessary fittings or trimmings, even including a smoke stack. They are entirely self-contained and mounted on wooden skids, ready to set up and fire. There is not even any fire brick to set as all fire brick linings in the combustion chamber and fire box are properly set in place in fire clay cement at the factory. For details of dimensions and accessories for each size boiler see page 21.

Boiler Plate Steel

The shells, heads and fire box of Leffel Scotch Marine Type Boilers are made of the highest grade Open Hearth Homogeneous Steel Boiler Plate, of not less than 55,000 and not over 65,000 pounds tensile strength, guaranteed to bend double when cold, when hot, or after heating red hot and plunging into water, as shown in Fig. 77. This material conforms in every way to the Standard Specifications of the Association of American Steel Manufacturers. Rivets are of best quality Open Hearth Extra Soft Steel, complying with the most rigid physical and chemical properties analysis. All tubes are of best quality seamless steel, properly expanded into the heads, with both ends beaded over in a workmanlike manner. All of the said material complies with all A.S.M.E. code boiler requirements.

Bracing

All braces, both through or diagonal type, are weldless mild steel. The size and number used are based on allowing a maximum load not exceeding 7,000 pounds per square inch of cross section of brace. Braces are so located that the pressure is distributed as nearly equally as possible.

Seamless Steel Domes

Seamless Domes formed from one piece of 5/8-inch Boiler Plate Steel are furnished on all Leffel Scotch Marine Boilers up to and including 50 H. P., as shown in the various illustrations. Larger sizes are equipped with Dry Pipe instead of dome.

Man-Holes, Hand-Holes and Openings

All 40 H. P. and larger Boilers are regularly furnished with 11x15-inch Man-hole in top of the shell; the smaller sizes of boilers down to an including 12 H. P. can also be thus furnished with Man-hole, when specifically ordered, and at extra cost.

All sizes 12 H.P. and larger have three Hand-holes in the front tube head—one above the tubes, and one on each side of the fire box flue, below the tubes; also two in the bottom of shell underneath, one near the front and one back of the blow-off pipe; also one in the top of the shell and one on each side of the shell near the rear end about one-fourth distance up from the bottom.

The 50 H.P. and larger sizes have one additional hand-hole, placed in the bottom of the shell directly below the circulating tube.

The 6. H.P. has a Hand-Hole in the front head above the tubes, and 1½-inch brass plug in the front head on each side of the fire box below the tubes, also a Hand-hole in the bottom of the shell underneath, one in the top of the shell and one in the shell on each side near the rear end and about one-fourth the distance up from the bottom.

Blow-off Pipe hole in the bottom of the shell is reinforced with steel plate riveted around same, and both thicknesses of plate are threaded.

Steam outlet pipe connections 2½-inch size and larger each have a suitable threaded steel reinforcing flange riveted on.

Grates

Grates with Bearers and Bridge Wall are supplied for burning coal, also wood that is free burning and not of too rough character; but for burning wood that is rather rough and not free burning, we recommend omitting Grates, Bearers and Bridge Wall, and substituting a series of Draft Holes through the bottom of the fire box flue and shell, as showin in Figure 76, page 15. Price is the same either way. Shaking and Dumping Grates are regularly furnished in 60 H. P. and larger sizes, (see page 12). On all other sizes, usual grates of double bar or two-finger type with about three-quarter-inch air space, with Bearers and Bridge Wall, are regularly furnished when not otherwise ordered. We have patterns for same style grates with 5/16-inch air space and Herringbone type grates with ½-inch air space that can be furnished when so ordered. Customers should always state kind and character of fuel to be used, so we can furnish grates best adapted to the conditions.

Boiler Supports

All Leffel Boilers of 100 H. P. and less have four heavy steel legs or brackets, securely attached to the shell for supporting the boiler on skids, piers, or other foundation. The larger sizes have six legs or brackets, three on each side. The 250 H. P. size is mounted on saddles.

Construction Details of Leffel Scotch Marine Type Boilers

Fig. 77—Leffel Boiler Plate Showing Cold and Quench Bend Tests.

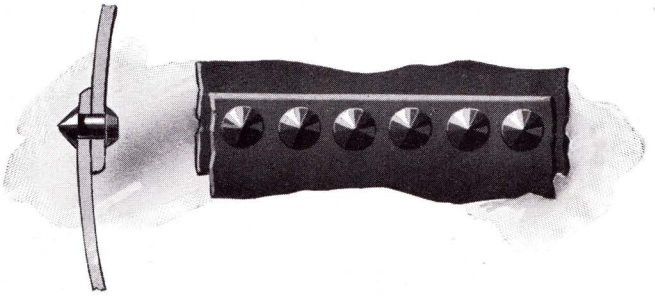


Fig. 78—Single Riveted Lap Joint. Efficiency 54 to 60 per cent. Used on all girth seams except middle girth seams of 75 H. P. and larger sizes.

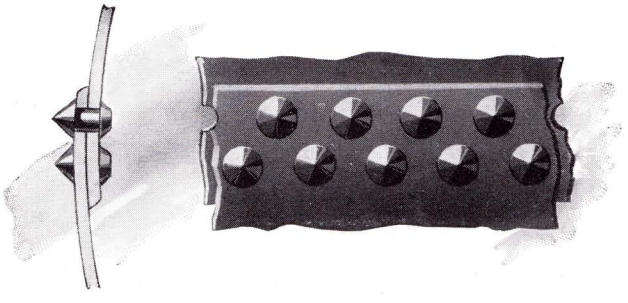


Fig. 79—Double Riveted Lap Joint. Efficiency 71 to 75 per cent. Used on horizontal seams of 6 H. P. and also on middle girth seams of all Boilers of 75 H. P. and larger sizes.

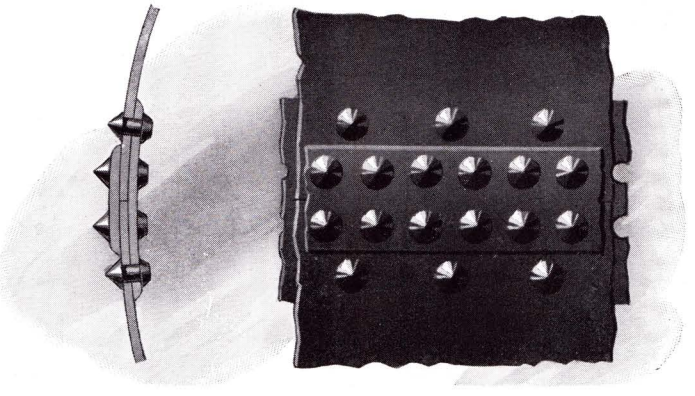


Fig. 80—Butt Joint Double Strapped and Double Riveted. Efficiency 81 to 83 per cent. Used on Horizontal seams of all Boilers of 12 H. P. to 35 H. P. inclusive, and also 50 H. P.

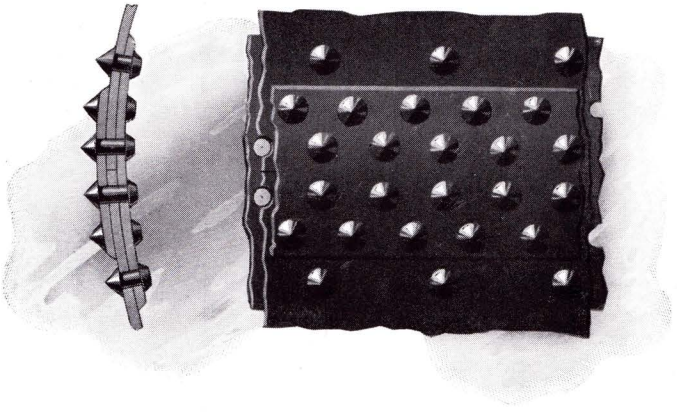


Fig. 81—Butt Joint, Double Strapped and Triple Riveted. Efficiency 85 to 88 per cent. Used on horizontal seams of 40, 60 and 75 H. P.

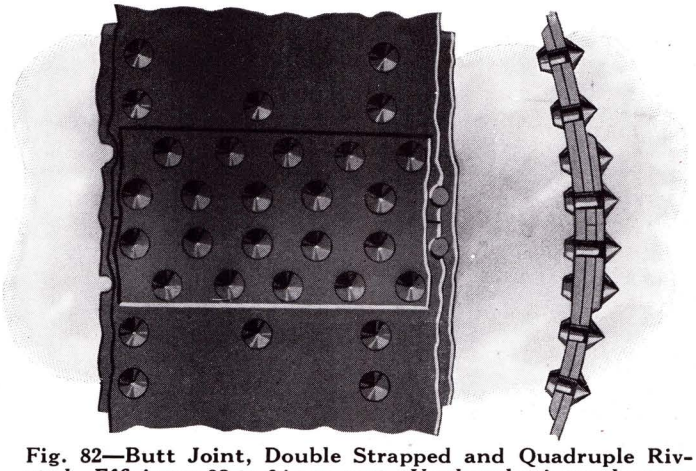
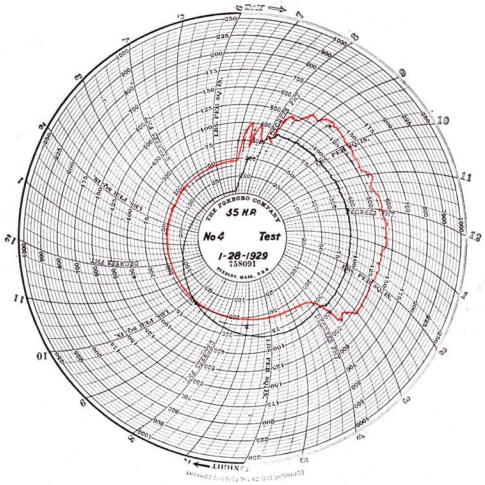


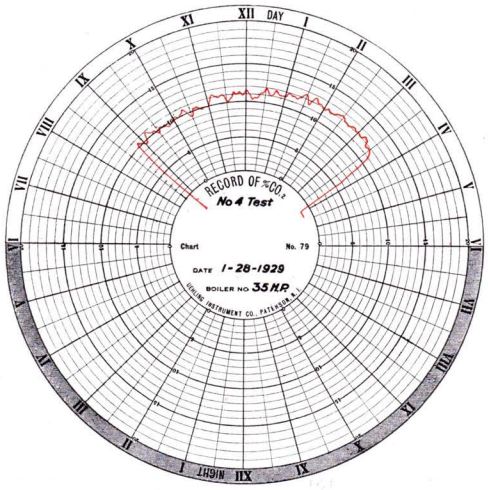
Fig. 82—Butt Joint, Double Strapped and Quadruple Riveted. Efficiency 92 to 94 per cent. Used on horizontal seams of 100 H. P. and larger sizes.

Test of a Leffel Scotch Marine Type Boiler

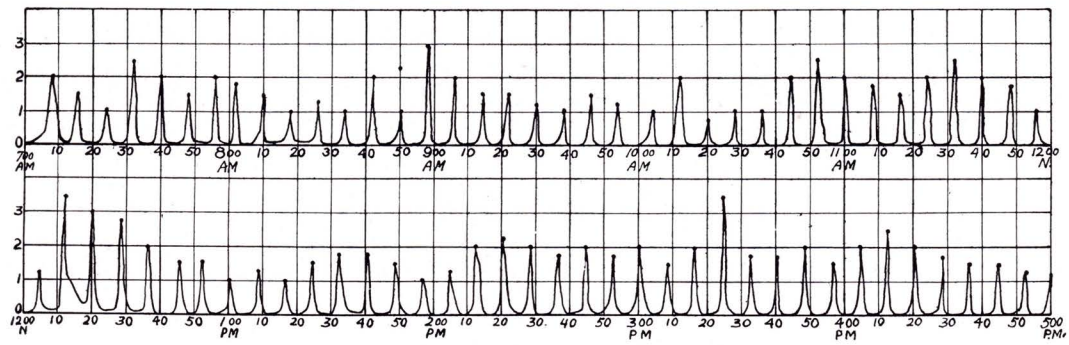
Hand Fired—using Red Jacket Coal



Temperature and Pressure Chart.
The Red line showing the temperature and the Black showing the Pressure.



Record of percentage of CO_2.



Smoke Observations—Firing period 8 minutes—139 lbs. of coal per hour—55 ft. stack.
Showing that Leffel Scotch Marine Boilers, when properly fired, are more nearly smokeless than many of the so-called Smokeless Boilers.
Practically no smoke was visible except a barely perceptible amount for a few seconds at the instant of firing.

The above charts show a record of one of the tests of a 35 H.P. Leffel Scotch Marine Boiler, made in January, 1929. This test was conducted under ordinary conditions; the firing was done by hand, the boiler was unjacketed (that is, a bare boiler without covering), in a cold, unheated room except for the heat supplied by radiation from the boiler; cold feed water was used. Under these conditions the records show exceptionally excellent results obtained, but no better than Leffel Scotch Marine Boilers are capable of doing in practice at any time.

Note particularly the uniform percentage of carbon dioxide, showing the very nearly complete combustion due to a proper mixture of air and combustible gases in the Leffel furnace. This indicates high efficiency with almost a complete absence of smoke, as indicated by the smoke chart above. In other words, the Leffel furnace is releasing the very highest percentage of heat units from the fuel for active work in making steam.

The chart shows the average uniform pressure and temperature over a testing period from 8:15 A. M. until about 3:45 P. M.; the maintained pressure was 90 lbs. and then at discontinuance of the test at about 3:45 P. M. the fire was banked and the pressure actually went down to only about 5 lbs. at 7:00 o'clock the next morning. That is, with the fire banked over a period of about 15¼ Hours there was still 5 lbs. pressure in the boiler. Complete details of this test are given on the next page.

Test of a Leffel Scotch Marine Type Boiler

Tabulation of Data from Test of a 35 H. P. Boiler made in January, 1929

Grate Surface	10.8 sq. ft.
Heating Surface	314 sq. ft.
Combustion Chamber	53 cu. ft.

Total Quantities

1—Date of Test	1-28-29
2—Duration of Test	7 hours
3—Weight of coal as fired	995 lbs.
4—Per cent Moisture in Coal	1.3%
5—Total Weight of Dry Coal	972 lbs.
6—Total Weight of Dry Ash and Refuse	85 lbs.
7—Per cent of Ash and Refuse	8.6%
8—Total Weight of Water fed to Boiler	9240 lbs.
9—Factor of Evaporation	1.21
10—Equivalent Evaporation from and at 212 deg. F	11181 lbs.

Hourly Quantities

11—Dry Coal Consumed per hour	139 lbs.
12—Dry Coal per sq. foot grate surface per hour	15 lbs.
13—Equivalent Evaporation per hour from and at 212 deg.	1597.4 lbs.
14—Equivalent Evaporation per hour from and at 212 deg. F. per sq. ft. grate surface	147.9 lbs.
15—Equivalent Evaporation per hour from and at 212 deg. F. per sq. ft. heating surface	5.08 lbs.

Average—Pressure and Temperatures

16—Average Steam Pressure by Gauge	94 lbs.
17—Average Temperature Steam Degrees F	334 deg. F.
18—Average Temperature Feed Water Entering Boiler	45 deg. F.
19—Per cent Dry Steam	99.4%
20—Average Temperature Furnace	2900 deg. F.
21—Average Temperature Combustion Chamber	1850 deg. F.
22—Average Flue Gas at Stack	605 deg. F.
23—Per cent CO_2 Flue Gas	11%
24—Horse Power Developed	46¼ H.P.
25—Coal per Horse Power as fired	3.08 lbs.
26—Dry Coal per Horse Power	3.01 lbs.
27—Builders Rated Horse Power	35 H.P.
28—Percentage Builders rated H.P., Developed	132%

Economic Results

29—Water Evaporation per pound of coal as fired	9.28
30—Equivalent Evaporation from and at 212 deg. F. per pound coal as fired	11.10
31—Equivalent Evaporation from and at 212 deg. F. per pound dry fuel	11.40
32—Equivalent Evaporation from and at 212 deg. F. per pound combustible	12.90

Efficiency

33—Calorific Value of Dry Coal per pound BTU	13704
34—Calorific Value of Combustible per pound	14800
35—Efficiency of Boiler based on Dry Coal	80½%

Comparative Superiority of Leffel Scotch Marine Boilers

The above data, as well as reports from users of Leffel Boilers over a period of many years show the many advantages of these boilers over other types.

They will evaporate more water per pound of fuel than other types of boilers.

The evaporation per sq. ft. of heating surface is greater than in other types of boilers.

They will deliver more steam per pound of coal than any other type of boiler of the same size.

They have a greater over-load capacity than other types of boilers of the same size.

They have more useful heating surface for a given size or capacity than other types of boilers.

The difference in temperature between the Furnace and the Stack shows the high efficiency of heating surface in utilizing over 80% of the available heat units in the fuel.

They save from 20% to 40% of the fuel required by other types of boilers.

They maintain their great economy throughout their entire life.

Lowest cost over a period of years compared with any other type of boiler.

Under careful tests Leffel Boilers always show greater economy in fuel and repairs than other types of boilers.

Leffel Boilers will last as long as they are kept clean inside and the water is maintained at proper level while in operation.

Satisfaction with any boiler is not a matter of low first cost, it is the ultimate cost and service rendered that counts. Leffel Scotch Marine Boilers are designed and built to deliver more than their rated power with less fuel, over a longer period of years, with ordinary care, and at less maintenance cost than other types of boilers.

In weighing evidence, remember that the Leffel Boilers have been specially built for many lines of industry over a long period of years; you will find them in all parts of the country, and there are thousands upon thousands of users who can testify to their satisfactory performance. The Leffel Engineers know the particular requirements of each industry and that knowledge is applied in every boiler made in this great factory.

Leffel Scotch Marine Type Portable Boilers

Internally Fired Return Tubular, A. S. M. E. Code

Comply with All State Boiler Laws

All Leffel Scotch Marine Boilers as well as parts and fittings are built and supplied to comply with the A.S.M.E. Code (American Society of Mechanical Engineers' Specifications . This code has been adopted as a boiler law in many states and large cities, and as other states are considering its adoption as a boiler law, we have decided to make all of our Scotch Marine Boilers to meet these rigid specifications for safety and durability.

Tested for Utmost Safety

A boiler that must be handled like a 21-jewel watch to keep it running and to prevent possible damage to life and property, certainly has no place in the average Power or Heating Plant. Every Leffel Boiler is tested under hydrostatic pressure of one and one-half times the working pressure, which assures a large factor of safety in actual use.

Water gauges and pressure gauges are placed within convenient view of the operator, but as a further precaution every boiler is equipped with a safety fusible plug, as a warning in case the water gets down near the danger point; and a safety valve as a protection in case the steam pressure becomes excessive.

Leffel Boilers are the safest type because their cylindrical design is the very strongest.

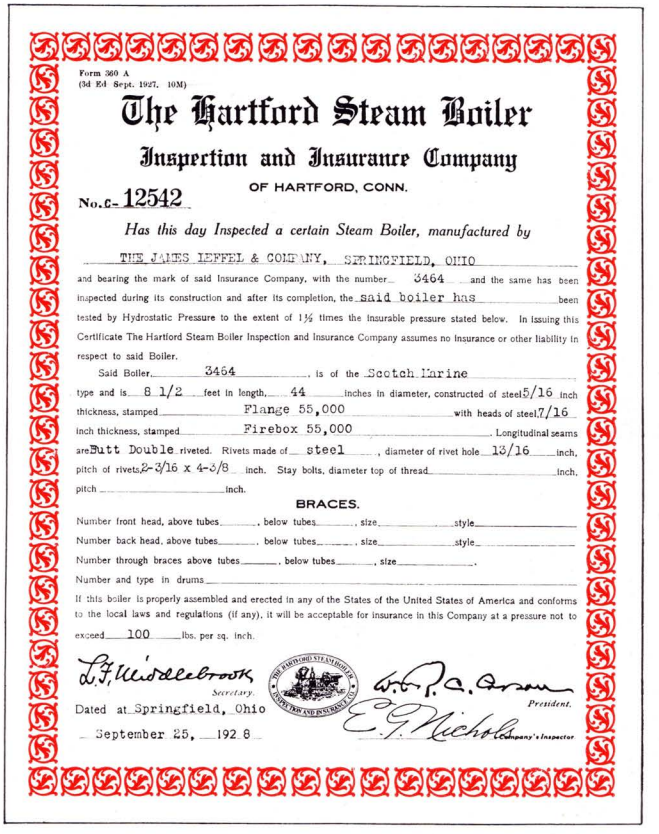
Certificate of Inspection and Test

The inspection and test are made under the supervision of a Hartford Steam Boiler Inspection and Insurance Co. inspector, who is also a qualified A.S.M.E. Code inspector and each boiler must conform to the rules, laws and requirements of any territory in which the boiler is to be placed. A Certificate of Inspection and Test by the Hartford Steam Boiler Inspection and Insurance Co. is furnished with every boiler. In addition to this, there is also furnished with each boiler a complete data sheet giving full details of materials, riveting, etc., signed by an authorized A.S.M.E. boiler inspector, showing that the boiler complies fully with every requirement.

Installation

The blue print accompanying this bulletin shows the over-all dimensions of the different sizes of Leffel Scotch Marine Type Boilers for the convenience of our customers in planning the proper setting for a boiler of this type. Dimensions on said blue prints are approximately correct but where conditions make close measurements necessary, on application, a separate blue print of any specific size, will be furnished. Leave space in the rear so the rear clean-out opening will be accessible for removing ashes that may accumulate back of the bridge wall or in the combustion chamber. Allow space on the side of the boiler where the fittings are to be placed so they will be conveniently accessible and in view of the fireman.

If so ordered, the boiler installation can be supervised by a Leffel Engineer and its operation can be carefully checked and watched by Leffel Service men.



Form 360 A
(3d Ed Sept. 1927. 10M)

The Hartford Steam Boiler
Inspection and Insurance Company
OF HARTFORD, CONN.

No. C- 12542

Has this day Inspected a certain Steam Boiler, manufactured by

THE JAMES LEFFEL & COMPANY, SPRINGFIELD, OHIO

and bearing the mark of said Insurance Company, with the number 3464 and the same has been inspected during its construction and after its completion, the said boiler has been tested by Hydrostatic Pressure to the extent of 1½ times the insurable pressure stated below. In issuing this Certificate The Hartford Steam Boiler Inspection and Insurance Company assumes no insurance or other liability in respect to said Boiler.

Said Boiler, 3464, is of the Scotch Marine type and is 8 1/2 feet in length, 44 inches in diameter, constructed of steel 5/16 inch thickness, stamped Flange 55,000 with heads of steel 7/16 inch thickness, stamped Firebox 55,000. Longitudinal seams are Butt Double riveted. Rivets made of steel, diameter of rivet hole 13/16 inch, pitch of rivets 2-3/16 x 4-3/8 inch. Stay bolts, diameter top of thread inch, pitch inch.

BRACES.

Number front head, above tubes , below tubes , size style
Number back head, above tubes , below tubes , size style
Number through braces above tubes , below tubes , size .
Number and type in drums

If this boiler is properly assembled and erected in any of the States of the United States of America and conforms to the local laws and regulations (if any), it will be acceptable for insurance in this Company at a pressure not to exceed 100 lbs. per sq. inch.

L. F. Middlebrook, Secretary.
W. P. A. Aron, President.
Dated at Springfield, Ohio
September 25, 1928
E. J. Nichols, Company's Inspector.

Future Service

The interest of the Leffel Engineers does not stop with your purchase of a Leffel Scotch Marine Boiler. On the contrary, they will always be most keenly interested in the successful performance of your boiler—not only that it may steam properly, but that it may give you good economy and satisfactory performance. Note on the back cover of this bulletin the widely distributed Leffel Sales and Service organization for the convenience of users of Leffel Boilers everywhere.

Responsibility

Over seventy-five years of progressive engineering experience is concentrated in the production of the highest quality of power machinery. A new million dollar manufacturing plant, thoroughly modern and completely equipped with the latest tools, arranged and specially adapted for the most efficient and economical production, assumes full responsibility for every product of this great factory.

Guarantee

All materials and workmanship throughout Leffel Boilers and Engines are guaranteed strictly first-class and entirely suited for the service intended. We will replace on board cars at factory, free of charge, any piece or part proving defective within one year from date of shipment.

Table No. 25—Specifications for Leffel Scotch Marine Boilers Built to the A. S. M. E. Boiler Code

Size No.	Working Pressure Pounds	Rated Horse Power	Inside Shell Diam. Inches	Fire Box		Thickness of Steel Plate			Return Tubes			Steam Dome		Steel Smoke Stack				Approximate Overall Dimensions Boiler		Approx. Shipping Weight on Skids with Reg Fixtures Less Stacl Pounds
				Diam. Inches	Length Grate Surface Inches	Shell Inches	Heads Inches	Fire Box Inches	Number of	Diam. Inches	Length Inches	Diam. Inches	Height Inches	No. Gauge Plate	Diam. Inches	Length Feet	Weight Pounds	Outside Di.when Covered Inches	Overall Length in Inches	
450	100	6	35	20	32	1/4	3/8	5/16	14	3	42	16	16	14	10	35′	420	40	70	2600
490	125					1/4	3/8	5/16												2600
550	150					5/16	3/8	11/32												2750
451	100	12	42	23	48	5/16	7/16	13/32	16	3	73	19	22	14	12	40′	495	47	102	5200
491	125					5/16	7/16	29/64												5300
551	150					3/8	7/16	1/2												5600
452	100	15	44	26	48	5/16	7/16	27/64	18	3	73	19	23	12	14	40′	840	49	102	5400
492	125					5/16	7/16	15/32												5550
552	150					3/8	7/16	17/32												5950
453	100	20	44	26	48	5/16	7/16	7/16	25	3	78	19	23	12	18	40′	1060	49	108	5700
493	125					5/16	7/16	31/64												6100
553	150					3/8	7/16	17/32												6500
454	100	25	44	26	48	5/16	7/16	31/64	25	3	96	19	23	12	18	40′	1060	49	126	6200
494	125					5/16	7/16	35/64												6700
554	150					3/8	7/16	19/32												7100
455	100	30	48	26	48	5/16	7/16	31/64	31	3	96	22	25	12	20	45′	1330	53	126	7300
495	125					3/8	7/16	35/64												8000
555	150					3/8	7/16	19/32												8350
456	100	35	48	26	60	5/16	7/16	17/32	31	3	114	22	26	12	20	50′	1455	53	151	8800
496	125					3/8	7/16	19/32												9200
556	150					3/8	7/16	21/32												9550
457	100	40	54	30	60	3/8	7/16	17/32	42	3	96	22	27	10	22	50′	1680	59	142	11250
497	125					3/8	7/16	19/32												11500
557	150					7/16	1/2	21/32												12000
458	100	50	60	32	60	3/8	1/2	5/16	45	3	114	26	27	10	22	60′	2020	65	160	13500
498	125					7/16	1/2	3/8												14200
558	150					7/16	1/2	3/8												14200
459	100	60	72	36	60	3/8	1/2	5/16	66	3	114			10	28	60′	2560	77	163	17500
499	125					7/16	1/2	3/8												18950
559	150					17/32	9/16	3/8												19500
460	100	75	72	36	72	3/8	1/2	5/16	66	3	144			10	28	70′	3230	77	196	20000
500	125					7/16	1/2	3/8												21000
560	150					17/32	9/16	3/8												22000
461	100	100	84	42	72	1/2	9/16	5/16	80	3	160			8	30	75′	4085	89	218	27600
501	125					17/32	9/16	3/8												28500
561	150					5/8	5/8	7/16												30200
462	100	125	90	45	72	1/2	9/16	11/32	102	3	160			8	34	75′	4700	95	219	32200
502	125					9/16	5/8	15/32												34900
562	150					11/16	3/4	15/32												36000
463	100	150	90	45	96	1/2	9/16	11/32	114	3	174			8	36	80′	5540	95	236	34800
503	125					9/16	5/8	15/32												37500
563	150					11/16	3/4	15/32												38600
464	100	175	96	48	96	1/2	9/16	3/8	136	3	174			5/32	38	80′	6080	101	237	39200
504	125					19/32	5/8	1/2												40700
564	150					23/32	3/4	1/2												42800
465	100	200	102	52	96	1/2	9/16	3/8	158	3	174			5/32	40	80′	6750	108	240	45500
505	125					5/8	11/16	17/32												49700
565	150					3/4	3/4	17/32												52200

Regular Equipment Furnished Includes: Wooden Skids on which Boiler is mounted; Front or Breeching with Smoke Door and Stack Nozzle; Fire Door and Ash Pit Door with Frame Fitted to front end of fire box; Grate Bars with Bearers and Bridge Wall at back end of grate surface; Fire Brick Lining fitted in end, sides and top of combustion chamber; Pop Safety Valve; Combination Water Column piped up to Boiler fitted with Glass Water Gauge, Steam Gauge with Brass Siphon and Cock and Gauge Cocks; Brass "Y" Renewable Disc Blow-Off Valve with Elbow and Pipe connected to Boiler; Injector with Piping, Globe, Check and Stop Valves fitted to Boiler; Ash Scraper, Flue Cleaner with Handle, extra Safety Plug and special Socket Wrench, for conveniently removing and replacing Safety Plug from outside.

All boilers of 60 H. P. and larger are equipped with Shaking and Dumping Grates; also Automatic High and Low Water Alarm Column, fitted with Chain Pull Gauge Cocks as regular equipment.

Steel I-Beams can be supplied in place of Wooden Skids, on all sizes, if desired, at an extra cost.

Leffel Engines and Scotch Marine Boilers

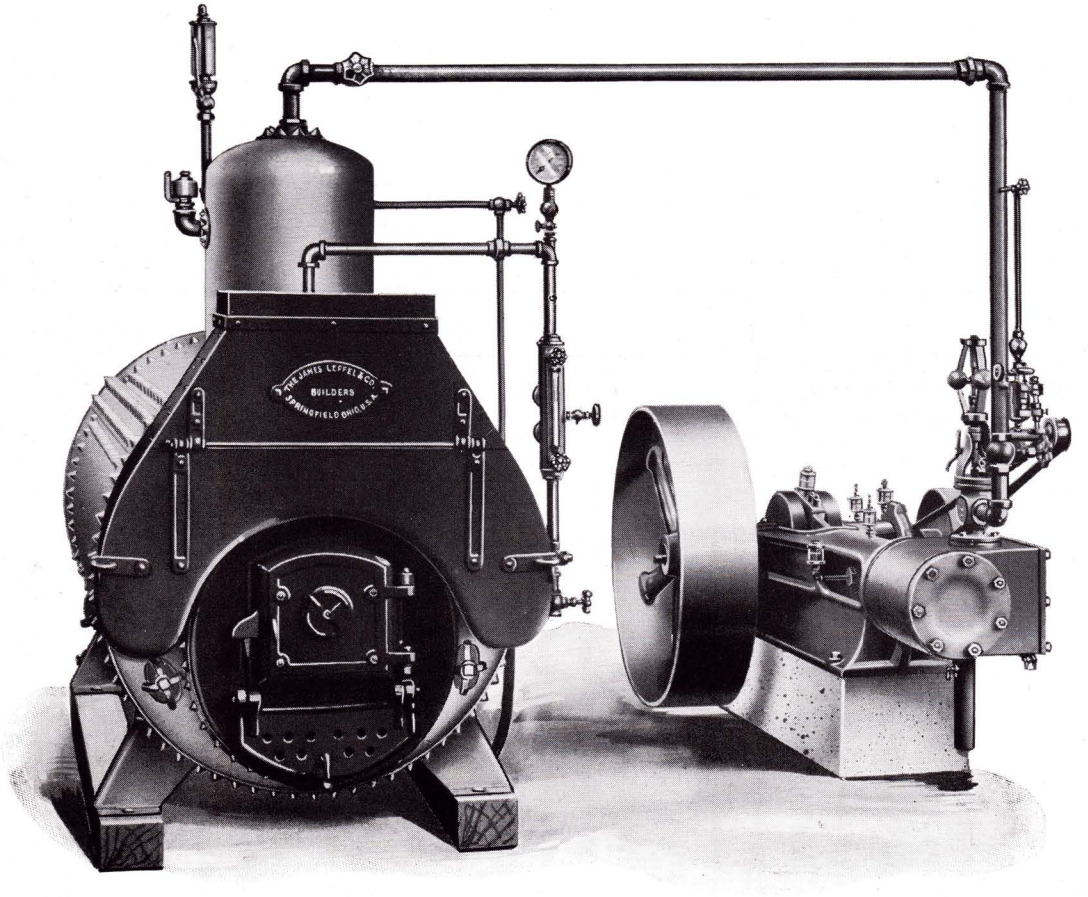


Fig. 83—Leffel Class "A" Engine and Scotch Marine Boiler.

If power is also required, it can be supplied at very little cost by installing a Leffel Class "A" Steam Engine and utilizing the exhaust steam for heating or other purposes. If your machinery is equipped with individual electric motor drive, then install a generator driven by a Leffel class "B" Automatic Regulating Engine. This will supply current for all power purposes, as well as all of your electric lights at surprisingly low cost because you will have all the exhaust steam you require for all of your heating and other purposes.

The Leffel Class "A" Throttling Governor Engines are made especially to meet conditions in the small power plant, because **they will give most satisfactory service for the longest time with the least care and expense.** When properly set on sub-base or foundation and adjusted to your requirements they almost take care of themselves. The Fly-Ball Governor, driven by belt from the shaft, is extremely sensitive to every change in load or steam pressure, opening and closing the throttle valve to admit the right amount of steam to maintain uniform, steady speed and power.

In the operation of plants, where dependable power is absolutely essential, Leffel Throttling Governor Engines are particularly desirable. There are no fine adjustments to require the frequent attention of an experienced engineer and even a considerable variation in the steam pressure will not seriously impair their operation.

Leffel Horizontal Center Crank Steam Engines

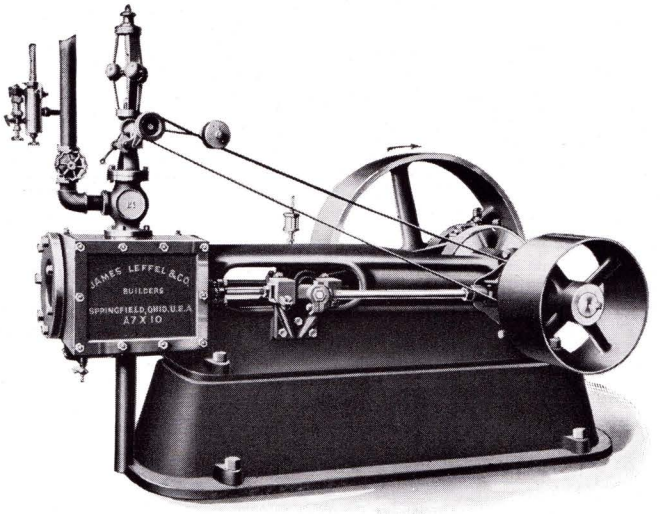


Fig. 84—Leffel Class "A" Throttling Governor Steam Engine showing construction of 7x10 and larger sizes. (Cast Iron Sub-Base is not furnished unless specially ordered.)

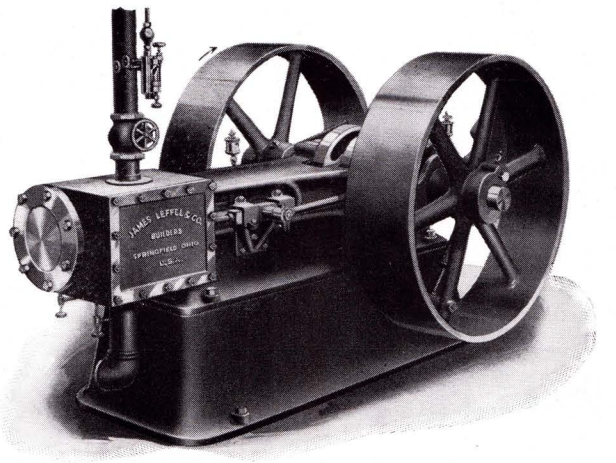


Fig. 85—Leffel Class "B" Automatic Cut-Off Steam Engine showing construction of 7x10 and larger sizes. (Cast Iron Sub-Base is not furnished unless specially ordered.)

The two driving pulleys on Class "A" Engines are interchangeable on the engine shaft, enabling one to use the engine as either a right hand or a left hand engine. The belt may be run either forward or backward from either or both pulleys so that two machines may be driven at different speeds if desired, and at the same time without a countershaft.

This engine is free from delicate or complicated parts and with proper care will be found durable and free from trouble.

All Leffel Class "A' engines are made to run either "over" or "under" and the eccentric is plainly marked so that the engine can be easily reversed, but unless otherwise specified, they are set at our factory to run "over" as indicated by arrows in the illustrations.

The Leffel Class "B" Automatic Cut-Off Center Crank Steam Engine is ideally suited for use in electric light and similar plants where constant speed and uniform acceleration are essential. It differs from the Leffel Class "A" Throttling Governor Engine in that the governor revolves with the fly wheel and automatically regulates the speed of the engine by action on the valve, varying travel of same in the steam chest—as opposed to the fixed cut-off of the steam supply as in the Throttling Governor type.

Class "B" Engines are regularly furnished to run "over" as indicated by the arrow, but can be furnished to run "under" if so ordered.

Under the care of an expert engineer the Class "B" engine is more economical in the use of steam than the throttling or fixed cut-off type, and gives closer speed regulation.

All reciprocating parts are symmetrical and well balanced so that these Engines operate quietly and with practically no vibration.

Every Leffel Engine is run, carefully inspected and tested under full load and steam pressure before leaving the factory.

They are guaranteed to be of ample capacity, and are built strong enough to develop the power ratings given on page 24, but Class "B" Engines are not recommended for duty beyond power ratings given for eighty pounds initial steam pressure in Table 11, page 24.

On application a separate Bulletin will be furnished, more fully illustrating and describing these engines in detail.

Leffel Engines and Scotch Marine Type Boilers

Table No. 9—Sizes and Specifications of Leffel Class "A" Engines and Scotch Marine Type Boilers

Size No. of Outfit	ENGINE						BOILER							Approximate Shipping Weight Pounds
	Rated Horse Power of Engine	Cylinder		Standard No. of Revolutions per Minute	Driving Pulleys		Rated Horse Power of Boiler	Shell	Tubes—all 3-In. Diam.		Fire Box		Smoke Stack or Chimney Length Feet	
		Diam. Inch	Stroke Inch		Diam. Inches	Face Inches		Diam. Inch	No. of Tubes	Length Inch	Diam. Inch	Length of Grate Surface Inch		
470	6	5	6	240	24 and 12	7 and 7	6	35	14	42	20	32	35	3800
471	6	5	6	240	24 and 12	7 and 7	12	38	16	73	23	48	35	5800
472	10	6	9	220	36 and 16	7 and 8	12	38	16	73	23	48	35	6300
473	12	7	10	180	40 and 24	10½ and 10½	15	43	18	73	26	48	35	6900
474	15	7	10	180	40 and 24	10½ and 10½	20	45	25	78	26	48	40	8500
475	16	8	10	180	40 and 24	10½ and 10½	20	45	25	78	26	48	40	8600
476	18	8	10	180	40 and 24	10½ and 10½	25	45	25	96	26	48	40	9100
477	20	9	10	175	42 and 30	10½ and 12½	25	45	25	96	26	48	40	9300
478	25	10	10	175	42 and 30	10½ and 12½	30	48	31	96	26	48	45	11800
479	30	9½	12	175	48 and 36	12½ and 12½	35	48	31	114	26	60	50	13700
480	35	10½	12	175	48 and 36	12½ and 12½	40	55	43	96	30	60	50	15400
481	40	10½	12	175	48 and 36	12½ and 12½	50	60	45	114	32	60	60	18400

In addition to the regular equipment furnished with the boilers and engines, as specified in tables 25, page 21, and 10 and 11 below, we include with each complete outfit of Boiler and Engine a Whistle and sufficient Steam and Exhaust Piping to set the Engine and Boiler as per dimensions table shown in blue print No. E2367, which may be had upon request.

Table No. 10—Sizes and Specifications of Leffel Class "A" Throttling Governor Center Crank Steam Engines

Size No. of Engine	Rated Horse Power	Cylinder		Standard No. of Revolutions per Minute	Large Driving Pulley		Small Driving Pulley		Diam. of Steam Pipe Inches	Diam. of Exhaust Pipe Inches	Diam. of Main Shaft Inches	Diam. of Crank Pin Inches	Approximate Floor Space Engine Occupies				Approximate Shipping Weight with Sub-base Pounds	Approximate Shipping Weight without Sub-base Pounds
		Diam. Inches	Stroke Inches		Diam. Inches	Face Inches	Diam. Inches	Face Inches					Length Ft.	In.	Width Ft.	In.		
1	6	5	6	240	24	7	12	7	1	1¼	1¾	1⅝	4	1	2	9	835	735
2	8 to 10	6	9	220	36	7	16	8	1¼	1½	2¼	2	5	7	3	0	1475	1250
3	12 to 15	7	10	180	40	10½	24	10½	1½	2	2⅞	2⅞	6	8	3	10	2400	2100
4	16 to 18	8	10	180	40	10½	24	10½	2	2½	2⅞	2⅞	6	8	3	10	2500	2200
5	20 to 23	9	10	175	42	10½	30	12½	2	2½	3⅜	3¼	6	9	4	2	2825	2400
6	25 to 28	10	10	175	42	10½	30	12½	2	2½	3⅜	3¼	6	9	4	2	2950	2515
7	30 to 34	9½	12	175	48	12½	36	12½	2½	3	3⅞	3¾	7	11	5	0	4450	4000
8	35 to 40	10½	12	175	48	12½	36	12½	2½	3½	3⅞	3¾	7	11	5	0	4550	4100

Regular Equipment Furnished Includes: Two Driving Pulleys, as illustrated and listed, turned, bored, balanced, key-seated and fitted to shaft; Fly-ball Throttling Governor with Automatic Safety Stop, Speed Adjuster and Sawyer's Lever, and bolts for bolting Governor in position to Steam Chest; Governor Belt; Throttle Valve with Nipple for attaching to Governor; full set of Nickel-Plated Adjustable Set and Sight-Feed Oil Cups, including Nickel-Plated Automatic Sight-Feed Cylinder Lubricator with connections; Oil Can; Cylinder Drain Cocks attached to Cylinder and Steam Chest; necessary Wrenches.

Special Equipment: Foundation bolts, Steam and Exhaust Pipe, and Cast Iron Sub-Base are not furnished unless specially ordered at an extra charge.

A Mechanical Force Feed and Sight Feed Cylinder Oil Pump can be furnished in addition to or in place of Lubricator at slight additional cost. Stationary Oil Cups with Traveling Wipers for Crank and Cross-Head Pins and Eccentric can also be furnished at an additional cost.

Table No. 11—Sizes and Specifications of Leffel Class "B" Automatic Cut-off Center Crank Steam Engines

Size No. of Engine	Indicated Horse Power at ¼ Cut-Off at usual number of Revolutions per Minute			Cylinder		Usual No. of Revolutions per Minute	Two Band Fly Wheels		Diam. of Main Shaft Inches	Diam. of Steam Pipe Inches	Diam. of Exhaust Pipe Inches	Approximate Floor Space Engine Occupies				Approximate Shipping Weight	
	70 lbs. Initial Pressure	80 lbs. Initial Pressure	90 lbs. Initial Pressure	Diam. Inches	Stroke Inches		Diam. Inches	Face Inches				Length Ft.	In.	Width Ft.	In.	with Sub-base Pounds	without Sub-base Pounds
20	15 to 18	17 to 20	19 to 23	7	10	225 to 275	40	10½	2⅞	1½	2	6	8	3	10	2800	2500
21	19 to 24	22 to 27	25 to 31	8	10	225 to 275	40	10½	2⅞	2	2½	6	8	3	10	2900	2600
22	25 to 30	28 to 35	32 to 39	9	10	225 to 275	42	10½	3⅜	2	2½	6	9	4	2	3300	2900
23	30 to 37	35 to 43	39 to 48	10	10	225 to 275	42	10½	3⅜	2½	3	6	9	4	2	3450	3050
24	33 to 40	38 to 46	43 to 52	9½	12	225 to 275	48	12½	3⅞	2½	3	7	11	5	0	5250	4800
25	36 to 45	41 to 51	46 to 58	10½	12	200 to 250	48	12½	3⅞	2½	3½	7	11	5	0	5350	4900

Regular Equipment Furnished Includes: Two Band Fly-Wheels, as illustrated and listed, one containing Governor, and both bored, turned, balanced, key-seated and fitted to shaft; Stop Valve with nipple fitted to steam chest; full set of Stationary Nickel-Plated Adjustable and Sight-Feed Oil Cups, including one each for Cross-Head Pin, Crank Pin, Eccentric, Cross-Head Guides, and each Bearing for Main Shaft; Compression Grease Cup for Governor Pivot Pin; also Nickel-Plated Automatic Sight-Feed Cylinder Lubricator, Oil Can, Wrenches, Drain Cocks for cylinder and Drain Cock for steam chest. Crank and Cross-Head Pins and Eccentric are also fitted with Traveling Wipers.

Special Equipment: Cast-Iron Sub-Base, Foundation Bolts, Steam and Exhaust Pipe, and any other equipment not mentioned herein are not furnished unless specially ordered, at an extra charge.

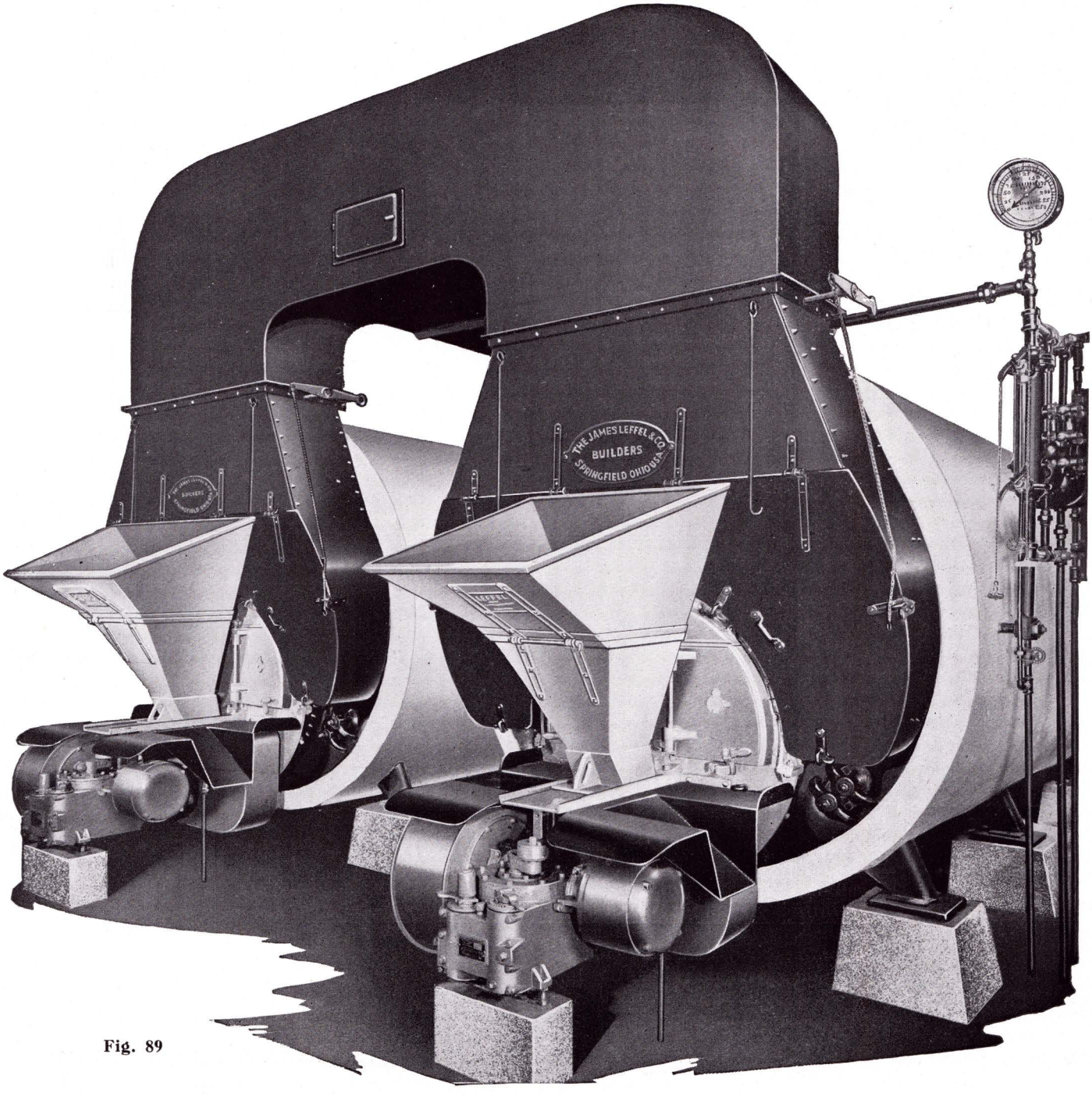


Fig. 89

Large Size LEFFEL BOILERS
Fired with LEFFEL UNDERFEED STOKERS

Will Steam DOUBLE Their Rating

THESE STOKER UNITS

Are Quickly Installed
Occupy Small Space
Convenient In Operation
Quickly-Easily Cleaned
Will Lower Your Fuel Costs
Will Eliminate Smoke
Have Extra Long Life
Safest Type Boiler Built

Sizes 15 to 250 Rated H. P.

75-80% Overall Efficiency

The James Leffel & Co.

SPRINGFIELD, OHIO

See Performance Data on page 26

Test No. 111

Results of Boiler Trial

PLANT OF —J. H. Day Company. DATE —June 9, 1936

CITY —Cincinnati. STATE—Ohio.

OBJECT OF TEST—Efficiency under normal load.

FUEL USED —2″ West Virginia Island Creek Mine Screenings.

CONDUCTED BY —H. M. Swindler. OBSERVED BY—Pat Burke, C. E.

MAKE OF BOILER—Leffel; TYPE—Scotch Marine; WATER HEATING SURFACE—2000 Sq. Ft.; RATED H. P.—200; TUBES—158-3″; SUPER HTG. SURFACE—29 Sq. Ft.; GRATE AREA—30 Sq. Ft.; FIREBOX SIZE—51¾″; COMBUSTION SPACE—259 Cu. Ft.; HOW FIRED—Leffel Stoker.

1. Duration	8	Hrs.
2. Steam Pressure	141	Lbs.
3. Steam Temperature	493	Deg. F.
4. Degrees Superheat	134	" "
5. Temp. of Feed Water	190	" "
6. Temp. of Gas leaving tubes	485	" "
7. Air Pressure	1.94	Inches
8. Furnace Draft	.14	"
9. Draft at Damper	.30	"
10. Draft at base of Stack	.33	"
11. CO2 (Sampling tube leaking air)		
12. Total weight of coal feed	6100	Lbs.
13. Total weight dry refuse	419	"
14. Ratio of refuse to coal	6.86%	
15. Total water fed—lbs.	64,112	
16. Factor of evaporation	1.139	
17. Total Water F. & A.—lbs.	73,024	

COAL ANALYSIS

18. Moisture	Per cent	1.92
19. Volatile	Per cent	38.25
20. Fixed Carbon	Per cent	54.32
21. Sulphur	Per cent	.95
22. Ash	Per cent	5.51
23. B. T. U. per lb. (as fired) average of (2) analysis		14,158

SUMMARY

24. Average Coal burned per hour, lbs.	762.
25. Average Coal burned per sq. ft., per hr., lbs.	25.4
26. Water evaporated per lb. of coal (actual) lbs.	10.51
27. Water evaporated per lb. (F. & A. 212°) lbs.	11.97
28. Average hourly evaporation (F. & A. 212°) lbs.	9128.
29. Average Boiler H. P. developed per hr.	265.
30. Per cent of rated capacity developed	132.
31. Efficiency of Boiler, furnace, grate and superheater	82.04%

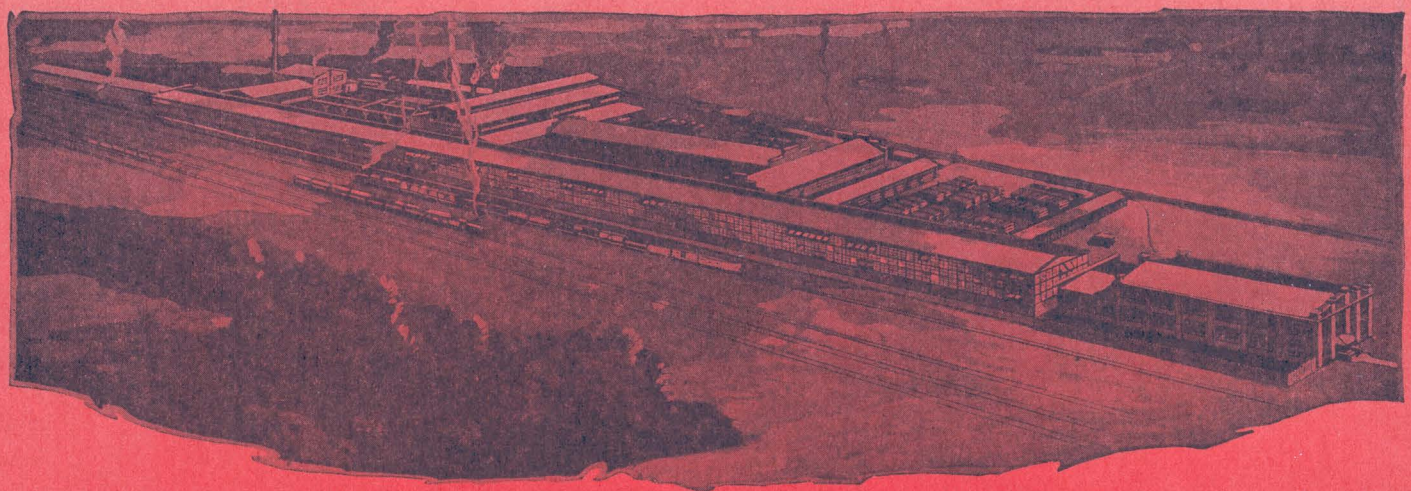
NATURE OF LOAD—250 K.W. Skinner Uniflow Engine Generator Set.

GENERAL CONDITION OF EQUIPMENT—Very good.

REMARKS—The load carried was their normal one and was handled easily. No objectionable smoke was noted during trial.

Boiler equipped with a Marley Superheater.

Approximate boiler horse power developed by hours—256, 256, 297, 242, 228, 297, 297, and 270.

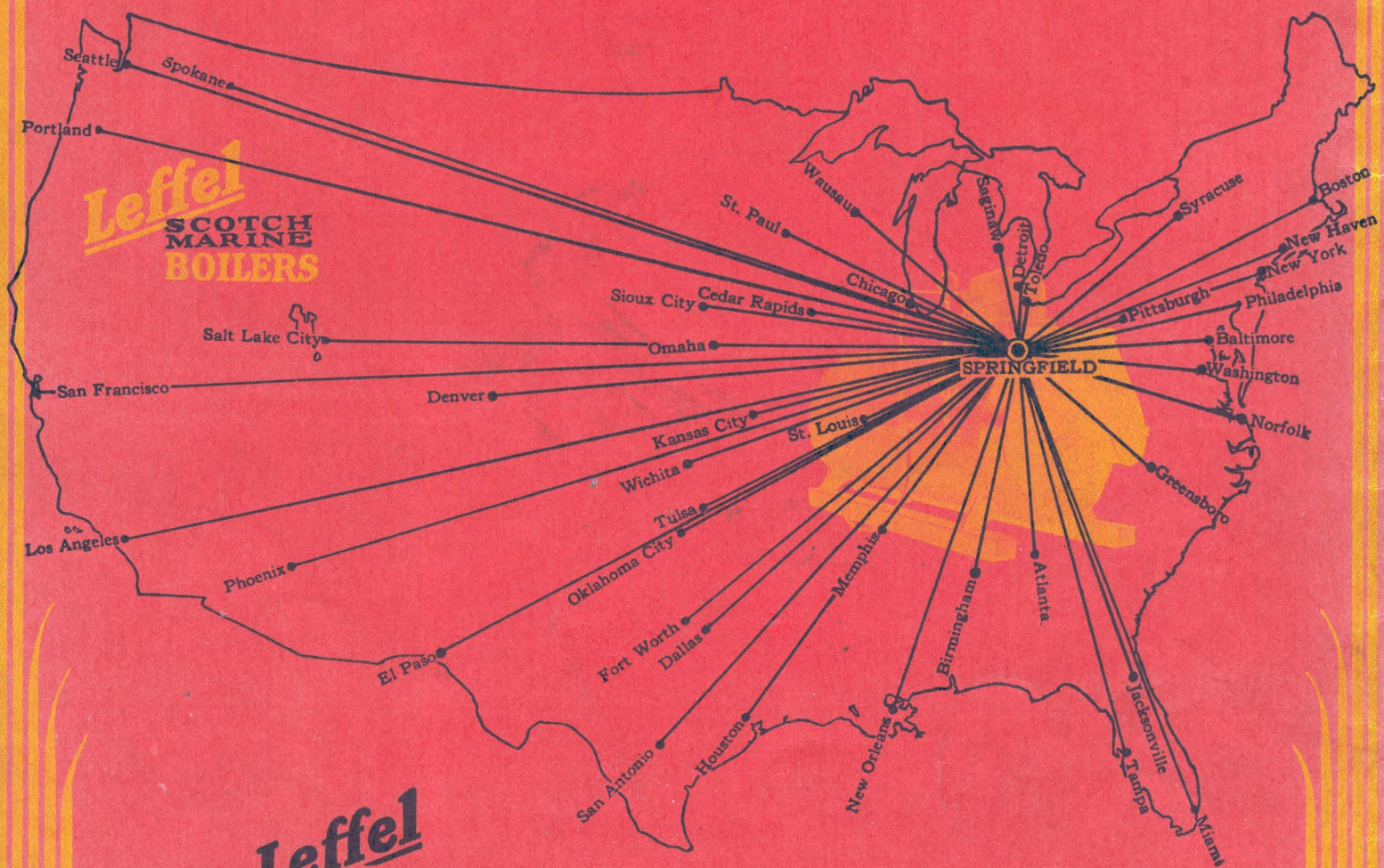


Birds Eye View of Factory and General Offices

The James Leffel & Co.

Springfield, Ohio, U. S. A.

SINCE 1862 MANUFACTURERS OF BOILERS AND STEAM ENGINES



Leffel

BOILERS *are sold and serviced everywhere!*

FROM Seattle to Miami—from Los Angeles to Boston—the Leffel dealer organization spans the country in order that representatives may be within easy reach of every possible user.